REVIEW

MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

Earth Sciences Data Information System (ESDIS)
Level 1 Product Generation System (LPGS) Integration and Test Plan

August 1997

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

REVIEW

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Prepared Under Contract NAS5-31000/HQ001057
By Computer Sciences Corporation
CSC 10034686

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Preface

This test plan addresses the Level 1 Product Generation System (LPGS) tests which will be conducted by testing personnel. The scope of the system is defined in section 1.2, LPGS Overview, Level 1 Product Generation System (LPGS) environment.

This test plan is a contractual requirement for the Code 514 portion of the CNMOS contract with Goddard Space Flight Center (GSFC) site of the National Aeronautics and Space Administration (NASA).

This document is controlled by the LPGS Project Configuration Management Board (PCMB) and may be changed by Document Change Notice (DCN) and/or revision procedures. Comments and questions regarding this specification should be directed to:

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Abstract

A comprehensive plan for the subsystem integration and system-level testing of the Level 1 Product Generation System (LPGS) is provided within this document. The testing process is documented from test preparation through test status summary reporting, and includes test methodology, functional responsibilities, test resource requirements constraints, and test set information.

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Section 1 -

1.1 LPGS Overview

The Level 1 Product Generation System (LPGS) is shown in figure 1-1. LPGS is a source of the Enhanced Thematic Mapper Plus (ETM+) Level 1 data within the ESDIS Ground System (EGS). Furthermore LPGS is located at the Earth Resources Observation System (EDC) Distributed Active Archive Center (DAAC) at the Goddard Space Flight Center (GSFC) and provides ETM+ Level 1 digital image generation and transfer services on a demand basis.
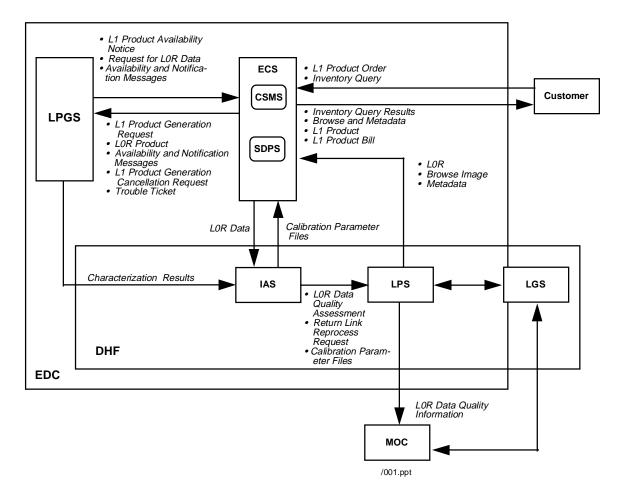
Figure 1-1. LPGS Environment

1.2 Applicable Documents

1. National Aeronautics and Space Administration (NASA), Goddard Space Flight Censer (GSFC), 430-L-0002-H, *Earth Science Mission Operations Landsat 7 System Specification*

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2. Martin Marietta Astro Space, *Landsat-7 Image Assessment System Operations Concept*, September 1994

3. Martin Marietta Astro Space, CDRL #A058, 23007610A, *Landsat-7 Program Coordinate System Standard, Rev. B*, December 1994

4. Martin Marietta Astro Space, CDRL No. A104, *Space Segment Calibration Plan*, August 1994

5. Computer Sciences Corporation, *Landsat-7 MOC to IAS Interface Control Document*

6. NASA, GSFC, 514-1 ICD/0195, Interface Control Document Between the IAS and the LPS

7. Hughes Information Technology System, 209-CD-013-002, *Interface Control Document Between ECS and the Landsat 7 System*

8. AlliedSignal Technical Services Corporation, *Landsat 7 Detailed Mission Requirements*, March 1996

9. Computer Sciences Corporation, *SEAS System Development Methodology (SSDM),* Copyright July 1989

10. NASA, GSFC, 514-1 ICD/0195, Landsat-7 Image Assessment System Element Specifications, Review March 1997.

11. Computer Sciences Corporation, *Landsat-7 Image Assessment System (IAS) System Design Specification, December 1996.*

12. Earth Sciences Data Information System (ESDIS) Level 1 Product Generation System (LPGS) *Preliminary Design Specification*, May 1997

13. Earth Sciences Data Information System (ESDIS) Level 1 Product Generation System (LPGS) *Output Files Data Format Control Book*, May 1997

14. Earth Sciences Data Information System (ESDIS) Level 1 Product Generation System (LPGS) *Interface Definition Document* (IDD), April 1997

15. Earth Sciences Data Information System (ESDIS) Level 1 Product Generation System (LPGS) *Functional and Performance Specifications*, 510-FPD/0196, February 1997

16. Earth Sciences Data Information System (ESDIS) Level 1 Product Generation System (LPGS) *Operations Concept*, 510-3OCD/0296, February 1997

17. Earth Sciences Data Information System (ESDIS) Landsat 7 Level 1 Product Generation Systems (LPGS) *System Design Specification*, 510-4SDS-0196, March 1997

18. Interface Control Document Between EOSDIS Core System (ECS) ESDIS Landsat 7 Level 1 Product Generation Systems (LPGS) , June 1997

1.3 LPGS Integration and Test Strategy

The purpose of system testing is to verify the requirements allocated to the LPGS and documented in the Earth Science Data and Information System (ESDIS) Level 1 Product Generation System (LPGS) Functional and Performance Requirement Specification (F&PRS); to identify system errors; and to ensure that the system is ready for release to acceptance test.

System integration tests are defined to exercise the LPGS with respect to performance requirements and operational procedures. Test scenarios that mimic the operational system include verification of the electronic interfaces between the LPGS and ECS. Implementation and test schedules of the LPGS and the EDC DAAC may impact this portion of LPGS testing, however, tools to simulate the other ground system elements will be used, when required, to verify the LPGS software.

Prior to the subsystem integration supported by this document, the LPGS software will be unit tested during development; the tested units will be integrated into modules and the modules into subsystems by development personnel working as an integration test team. When the software has been integrated that far, the subsystems will be turned over to the subsystem integration test team. Subsystem integration testing verifies the internal interfaces between system components. In addition to testing the interfaces between individual subsystems, string testing will be performed to flow data from end to end of the software in a given release. Problems identified during subsystem integration will be documented as Internal Configuration Change Requests (ICCRs) and corrected as time permits and the LPGS team deems appropriate. An informal summary of the results of subsystem integration testing will be documented at the end of that test phase.

Section 2 - Test Activities

Section 2 presents an overview of testing and describes the typical activities performed by the test groups throughout the project lifecycle.

2.1 Test Preparation

The test preparation phase consists of test plan development, test tool preparation, test data generation, test personnel training, and test environment preparation. At the end of the initial test planning phase, and prior to system testing of each build, preparation includes test procedure definition, the Test Procedures Walkthrough (TPW) and the System Test Readiness Review (STRR).

2.2 Test Conduct

When test preparation is complete, the test group moves into the test conduct phase for the current build. The primary activities of this phase are test execution and analysis of the software functions and/or output files. In addition, status and progress are reported and problem reports are generated. For a build that will be released to the customer, the delivery package is finalized during the system test conduct phase.

2.3 Test Reporting

Test reporting for LPGS includes preparation of weekly test status reports, daily productivity status reports, and formal STRRs for system testing. A summary of the test execution, problem reports, and major milestones is provided in the weekly status reports, along with the overall progress of testing. The weekly test status reports are provided to CNMOS management during the entire test life cycle and incorporated into the weekly LPGS status reports provided to Goddard Space Flight Center (GSFC). Productivity status information is provided during test conduct and contains totals of tests executed and ICCRs written. A summary of the major problems encountered and major milestones completed for the day is included with this report. The report is provided to the LPGS test lead and is available for LPGS project management and GSFC, if desired. Meetings on the test status are held periodically during the test execution phase, as needed.

2.4 Test Data

Development, integration, and system test personnel require data to test individual units, modules, subsystems, and the LPGS system as a whole. The Generic Telemetry Simulator (GTSIM) Data will be used throughout the LPGS lifecycle to generate raw wideband data in the format defined for the Enhanced Thematic Mapper Plus (ETM+) instrument of the Landsat 7 satellite. Section 7 Test Resource Requirements of this document, contains a more detailed discussion of test data requirements and sources.

2.5　Test Tools

LPGS testing will verify the Level 1 product generation and will depend heavily on data dump and analysis tools. Integration test will require drivers and stubs to stand in for software scheduled for later development. To eliminate dependence on the development schedules of other facilities, LPGS testing will modify the existing ECS simulator to support the protocol message exchange between LPGS and ECS. Specifics on test tools and tool configuration are documented in Section 5 Configuration and Data Management and Section 7 Test Resource Requirements.

2.6　Internal Configuration Control

Maintaining configuration control of LPGS software, tools, data, and environments is necessary to minimize the effort and risks inherent in developing and testing changeable software. The Configuration Management section of the Integration and Test Department and the applicable test groups are each responsible for configuration control. These responsibilities are described in further detail in Section 5 Configuration and Data Management, of this plan.

Section 3 - Subsystem Integration Testing

Section 3 describes the preparation for and execution of subsystem integration testing for the LPGS application software.

3.1 Objectives

The integration test effort is designed to verify software subsystem interfaces, including the data passed in those interfaces. The integration team tests the LPGS software to verify accuracy in digital imagery, exercise error handling paths, verify path coverage in general, and to test functional performance.

3.2 Test Cases

An integration test case consists of the purpose of the test, a description of the test case, prerequisites and dependencies, initialization and input requirements for the test, expected outputs and test evaluation criteria.

Integration tests are designed using the Interface Definition Document (IDD) to map interactions between subsystems. A class of valid inputs is identified for each interface, and tests are defined to use a random or representative subset of those values. Invalid inputs and boundary conditions are identified, and one test case may be used to verify nominal, boundary and error conditions by changing input criteria.

3.3 Test Execution

Installation of software subsystems and test execution is performed in the subsystem integration test environment, separated and under separate configuration control from the development environment. Test execution is scheduled based on identified test dependencies and the order in which subsystems are turned over to the integration team.

The integration team will identify test cases to be executed based on the contents of a release. Prior to the first turnover, integration test will hold an informal walkthrough to present the tests planned for the current release. A test is considered unsuccessful when the results do not match the expected output; early review and discussion of the integration test plan by development personnel is essential to streamline test execution.

3.3.1 Internal Interfaces

Integration tests will verify the interfaces between and among subsystems (i.e., each interface between two subsystems, and all interfaces among a group of subsystems), until the implemented software has been fully integrated. For early builds, when implementation of a given subsystem is not complete, test tools will substitute for undelivered units.

Unit and module integration is completed by the development team prior to software turnover to the subsystem integration testing team. The team tests the interfaces between subsystems, including interfaces between LPGS subsystems and external interfaces.

3.3.2   String Testing

Software turnovers to subsystem integration are expected to be staggered according to the development schedule for each subsystem. The last turnover of an LPGS subsystem must occur at least one week before turnover to system test. When the subsystems have been integrated, tests will be executed to verify the data and process flows from initial input to the LPGS through final output from the LPGS.

The Landsat 7 Ground System Integration and Test (I&T) will be supported by released or engineering versions of the LPGS software (dependent on Ground System I&T schedules). For subsystem integration, external elements may be simulated to verify the LPGS software at those interfaces and to flow data from end to end of the LPGS.

3.3.3   Confidence Tests

At the end of the integration test phase, and in preparation for system test, the two test teams will execute confidence tests. Configured data sets are processed by the LPGS software in the integration test environment. Behavior of the software and data results are recorded. After the LPGS software is installed in the system test environment, the same configured data sets are processed in that environment. Results are compared to integration test results to obtain a quick confidence level in the installation process and software.

3.4   Analysis and Reporting

An informal, daily report of integration test progress and unresolved issues will be prepared by the test team for project management. A more formal accounting of tests executed versus tests scheduled; successful and unsuccessful test numbers; number, priority and type of ICCRs written and resolved; and status of integration test issues will be prepared on a weekly basis.

The level of analysis required to determine the status of an executed test will vary with the test. The expected results documented in each test case description range from observation of an event to analysis of data integrity for a file. Any test whose results fail to match the expected output is an unsuccessful test, and the integration team will refer such anomalous or unexpected test results to the software development team for further analysis.

3.5   Problem Reporting

Software problems encountered during the subsystem integration test phase will be documented as ICCRs, using the Interactive CCR Automation System (ICAS) system. The ICCR process is a simplified and internally controlled system which minimize the time to correct errors can be minimized without compromising configuration control in the integration environment. The unresolved ICCRs from subsystem integration test will be placed under CRB control after software turnover to system test.

The number of procedural and set-up errors, or errors due to implementation changes, should be reduced by the test walkthrough. In order to eliminate unnecessary or incorrect error reporting even further, development personnel should be available for consultation during integration test execution. If an error is serious enough to suspend test execution, integration and development task leads will coordinate immediate analysis. Otherwise, integration test errors will be discussed at the daily status presentation before being entered into ICAS.

3.6   Subsystem Integration Test Summary

After software turnover to system test, the integration team will prepare an informal report of testing. The report is an overall evaluation of the formal integration test phase, including a summary of problems encountered and resolved, and a list of outstanding problems.

3.7   Lessons Learned

Immediately after turnover to system test, the integration test team holds a Lessons Learned meeting. Any problems encountered during the test phase are discussed, with an eye toward identifying process changes that can be implemented for the next integration test phase. Meeting minutes are prepared, listing action items and due dates. The integration task lead is responsible for follow-up for action items and process improvement initiatives. Meeting minutes will also be stored on the server for history.

3.8   Subsystem Integration Test Schedule

The following is a schedule for subsystem integration test planning and execution for the three LPGS builds. The date listed for each item is the COMPLETION date, unless otherwise indicated. All dates are relative to the date of the turnover to System Test. The planned turnover dates will be maintained in the Release Implementation Plan.

Activity	Completion Date
Test data selection	turnover - 9 weeks
Test data identification	turnover - 9 weeks
Integration test walkthrough	turnover - 8 weeks
Test environment setup/cleanup	turnover - 5 weeks
Test data generation/verification	turnover - 4 weeks
First turnover of subsystem(s)	turnover - 4 weeks
Last turnover of subsystem(s)	turnover - 2 weeks
Subsystem integration	turnover - 1 weeks
String testing	turnover - 1 day
Turnover package preparation	turnover - 1 day
Turnover to system test	turnover + 0 days
Confidence testing	turnover + 3 days

Section 4 - System Test

4.1 Objectives

The primary objective of system testing is to verify the functional, operational, and performance requirements allocated to the LPGS. The Level 1 Product Generation System (LPGS) Functional and Performance Requirements Specification (F&PRS) are the basis for the system test design defined in this plan.

In addition to requirements verification, system testing includes running operational scenarios, simulating a "day in the life" for operational software. End-to-end testing is also performed, encompassing LPGS software functions and interfaces with external elements of the Landsat 7 ground system.

4.2 Test Case Definition

System test cases are mapped to the Earth Science Data and Information System (ESDIS) Level 1 Product Generation System (LPGS) Functional and Performance Requirements Specification and are designed to exercise LPGS processes in a manner that verifies that allocated requirements are satisfied. For requirements that are satisfied by operational procedures rather than software, test cases follow the scenarios defined in the operations concept document.

Functional tests focus on valid, invalid or incomplete keyed and data inputs to the system. Performance tests focus on data volume capabilities, response times, and data throughput. Operational scenario testing exercises system functions in combinations that are most likely to occur during daily operations.

System test cases are grouped under functional test sets. A system test set consists of a purpose, high level description of the tests to be performed, testing dependencies, test methods and an overview of expected output. Test cases include a description of the test and data, and a list of the requirements satisfied with successful execution. Because test sets group similar tests together, the data, resources and expected results are defined at the test set level. When individual tests diverge from the test set norm, more details of resources and output are included at the test case level.

4.2.1 Test Ordering and Dependencies

System test cases are grouped into test sets by LPGS function. Tests within a set are generally independent of each other, but may follow a data flow that defines the order of test execution. Likewise, test sets must be executed in a specific order (e.g., data receipt must precede data processing), unless simulations are used to satisfy the prerequisites for test execution. Details of test dependencies are documented along with the description of each test set.

4.3   Test Procedures

The system test procedures consist of step-by-step instructions for executing individual test cases. Test procedures are written based on details of LPGS operations documented in the User's Guide. An initial set of procedures is developed for a release, presented at a Test Procedures Walkthrough, and modified as necessary before testing begins. The set of test procedures baselined for the release is added as an appendix to the I &T Plan. During system test execution, the procedures are red-lined to adjust for software changes and omissions in test steps. At the end of the system test phase, the procedures are updated per red-lines, and form the basis of the next release's test procedures. At the completion of the last system test phase, the I & T Plan contains the comprehensive test procedures for the LPGS.

Test procedures typically consist of

- Test set name and number

- Test case number and description

- Test execution dependencies

- Test data description

- Test tools required

- Check-off list of steps to execute test

- Check-off list of expected results

- Success criteria, where applicable

- Requirements satisfied by successful execution

Because many LPGS requirements map to low-level tasks within the LPGS processing function, system test cases will not have a one-to-one correspondence to requirements. For more complicated test cases, the test steps will be mapped to expected results, which will be mapped to individual requirements. This process will allow test cases and procedures to follow the operation of the LPGS system without complicating the analysis required to assess test results.

4.4   Test Procedures Walkthroughs

A Test Procedures Walkthrough is held for each release as part of the test planning phase. The TPW is conducted to ensure that the proposed test procedures adequately describe the operation of the system and verify the system requirements implemented for the current release. The walkthrough should be attended by representatives from development, integration and test, systems engineering, product assurance and project management.

A review package, containing all test procedures to be executed during the system test phase, should be distributed a week before the scheduled TPW; reviewers should have sufficient time to prepare comments and questions before the meeting. At the walkthrough, an overview of the test methods, test data, tools and other resources employed for testing the release is presented by

system test personnel. Review of the individual procedures is driven by comments on test execution steps, expected output and/or success criteria.

4.5   System Test Readiness Review

A System Test Readiness Review (STRR) is conducted to assess the readiness of the system, the test environment, and the system test team for system testing. The degree of formality of the STRR depends on scope, size, and criticality of the system.

The STRR should be conducted at least one week before the scheduled turnover to system test, but less mature systems (i.e., early releases) should be held as far in advance of the turnover as possible. The system test team facilitates the meeting, but the readiness of different areas will be presented by the following groups:

1.   Software support - software development

2.   Subsystem I&T results - integration test

3.   Test environment - configuration management

If the STRR assessment shows that any review element is not ready, a plan for implementing corrective action should be established within a timeframe that allows for reassessment before turnover.

4.6   Test Execution

The test sets and test cases documented in this test plan are high level descriptions of test to be performed during the lifecycle of the LPGS project. Details of test cases will be documented in the test procedures associated with each release.

All tests are executed as described in the test procedures. Problem reports are generated when discrepancies exist between the expected output and the actual results of the test. Expected outputs are noted in each test procedure, and concurred upon by the project at the Test Procedures Walkthrough.

The success criteria stated for each test case acts as a pass/fail indicator for statistical reporting during the system test phase. Success criteria are also reviewed at the Test Procedures Walkthrough.

In addition to providing test execution steps and criteria for assessing test results, the test procedures are used as test logs. The procedure is written as a checklist, which allows the tester to indicate exactly where problems were encountered, which test step or output was the basis for ICCR generation, the date of test execution, the status of test results, and any comments pertinent to the test.

4.6.1   Functional and Performance Tests

Functional tests are defined to verify functional requirements specified in the LPGS Functional and Performance Requirements Specification. Nominal input conditions are defined for every

functional requirement test, abnormal input conditions (e.g., incorrect input, incomplete or invalid data) are defined for appropriate and representative tests. Functional tests are executed during all releases, and are the primary focus of the first two releases of the LPGS. They also become the basis for building the regression test set for subsequent releases.

For a given release, functional tests are scheduled to exercise:

- New functions

- Most used functions

- Most important functions

- Hardest to develop functions, if applicable

- Least time to develop functions, if applicable

- Least unit-tested functions, if applicable.

- Performance tests are defined to verify the performance requirements specified in the Level 1 Product Generation System F&PRS, such as:

  - Overall performance (system monitoring and utilization)

  - Data volume

  - Storage limits

  - Usability (operator interface and user's guide)

  - Reliability recovery and availability

  - Response times.

System tests for performance verification are executed when the software is fully implemented and the hardware is available. Performance tests cases are defined mainly in the System Integration Test section of this document.

4.6.2   External Interfaces

External interface tests are defined to verify the LPGS software that supports interfaces with external elements of the EOS Ground System, as specified in the LPGS Functional and Performance Requirements Specification. Tests will be executed for all releases of LPGS Release 1 testing is expected to utilize interface simulators, while subsequent releases will require coordination with the facilities with which the LPGS will interface. However, if the external facilities are available before release 2 testing, release 1 software will be used for external interface testing.

4.6.3   Operational Scenarios

Operational scenario testing is defined to verify the requirements in the LPGS Functional and Performance Requirements Specification that are not satisfied by software or hardware

implementation. In addition, scenarios described in the LPGS Operations Concept document are tested to verify the feasibility of the workload assigned to the LPGS operators.

Operational, performance, and end-to-end tests are combined to provide "day in the life" testing in which the LPGS is up-and-running for a minimum of 24 hours.

4.6.4   End-to-End Testing

End-to-end testing verifies the LPGS capability to support input-to-output testing. Data is processed through the entire system, from the receipt of L0R products from ECS. Also, the creation and format of L1R and L1G products retrieved by ECS. Different scenarios are established for nominal processing, reprocessing and processing data with correctable errors. End-to-end testing is also employed in system integration testing and performance verification.

4.6.5   Confidence and Regression Tests

Both confidence and regression tests use a baselined set of data to make a quick, initial assessment of the LPGS software installed in the system test environment.

For confidence testing, nominal data successfully processed in the integration test environment are passed to the system test group to process. Duplicate results in the two environments provide a high level of confidence in the release process. Confidence tests are executed starting with the first turnover of the first release.

In contrast, regression tests are executed for turnovers made after a stable software baseline has been verified in the system test environment. After successful execution, nominal functional test cases may be moved to the regression test set. The data associated with the original tests and the test results are configured for use and comparison in later regression testing. Changes to the LPGS software that affect the results of baselined test cases may affect the regression test set, requiring certain tests to be suspended from regression testing until a new data set has been tested and configured.

After an initial regression set can be baselined, regression tests are executed for each subsequent turnover to the system test group. A subset of the regression test set is identified based on the contents of the individual turnover; the full regression set is executed prior to delivery for releases. Wherever possible, regression testing is automated to run without impacting test time.

4.7   Verification Methodology

Most requirements will be verified by testing, in which expected results derived from the requirements are the basis for assessing actual test results. Those requirements not verified by testing are verified by inspection, analysis or demonstration. Data formats and report contents are typically verified by inspecting the output for compliance with the applicable requirements. Inspection is also performed on hardware, code, program design language (PDL), and other documentation. Performance requirements are verified by testing followed by analysis to further interpret the results. Requirements relating to the operator interface may also be verified by human factors analysis. Requirements that are satisfied by implementing operational procedures

can be verified by demonstrating that the procedures is practical and possible. The verification methodology for tests is noted along with the test set description.

4.8   Analysis and Reporting

Most of the analysis performed during the system test phase will be through data file comparison. For releases that employ regression testing, the output files from newly executed tests are analyzed with respect to the configured output of the regression tests. Output data from individual tests are analyzed with respect to the input data, for both nominal and anomalous data handling. All data generated by the LPGS is collected and analyzed to determine whether output files meet the established criteria documented in the system test procedures.

Upon completion of the system test phase for each release, test procedures are reviewed for completeness, and the status of their associated requirement(s) is documented in a system test verification matrix. The Requirements and Traceability Management (RTM) tool will be used to generate the traceability matrix, and to store the status of test execution.

Test progress statistics are collected on a daily basis. In addition, status reports are prepared on a weekly basis and included in the weekly reports to GSFC. At the conclusion of all testing for a release, a test status summary report is generated based on the results of requirements verification during the system test phase. The test report for an undelivered release is less formal, and available within two weeks of the end of testing. Reports for software release testing are available within a month of test completion.

4.9   Anomaly Reporting and Change Control

Any tests outlined in this document that fail to generate the expected results may be rerun to verify that, if a problem does exist, it can be recreated and the test results maintain consistency. Problems that are not repeatable are still documented and noted as non-repeatable. ICCRs are documented through ICAS and reviewed by system engineering to determine whether they are in the scope of the LPGS requirements and design implementation. ICAS maintains a database of the ICCRs for approvals, analysis, implementation, tracking and report generation.

Problems found during system test are resolved by interim turnovers of modified software, depending on the severity of the problem and the test time remaining until the delivery deadline. During test phases, the Configuration Review Board (CRB) will meet as often as necessary to make timely decisions on the disposition of software problems encountered during testing. The decision whether to change the system test software with emergency or patch turnovers will be made by the CRB, however, no changes will be made to the system test baseline without a formal turnover of configured software. Any problems included in a turnover package will be tested and documented in the ICAS system. The tested ICCRS will be returned to the CRB for final closure

4.10   Requirements Traceability

The mapping, by test case, is part of the System Test Sets section of this document. This section contains the test requirements & verification matrix generated from RTM.

To ensure that all requirements for the LPGS are addressed, each system test case is mapped, using the RTM tool, to the requirement(s) it is designed to verify.

The initial test execution schedule is derived from the LPGS Release Implementation Plan, and is subject to change. Updates to the LPGS System Test Requirements Verification Matrix are made after each Test Procedures Walkthrough (to update the test execution schedule), and after the completion of system testing (to update the test results). A requirements verification matrix is included in the delivery package for software releases.

4.11 Lessons Learned

At the end of release testing, or after software delivery to the customer, the system test team holds a Lessons Learned meeting. Any problems encountered, as well as successful procedures employed during the test phase are discussed. Test management personnel are in attendance and are responsible for resolution of issues and implementation of changes that require management level approval. Meeting minutes are prepared with action items and due dates, which should be scheduled for changes to be implemented before the next test execution phase.

4.12 Test Assumptions and Constraints

Specific test assumptions are covered in the listing of resources required for each test set (i.e., it is assumed the specified resources will be available before the related tests are executed). Additionally, the system test group expects:

- to have access to any tools used by development and integration for testing

- that a draft of the User's Guide will be available approximately 5 weeks before the first turnover from integration test as a resource for test procedures development

- that the software turned over to system test will include "best guess" values for the static data in the database, and tools to automatically load that data

- that the minimum amount of system time (8 hours a day, 5 days a week) will be available during the test execution phase

The system test phase of the LPGS is planned based on the software implementation plan and published schedules for development and test. Test schedules are affected by changes in turnover schedules, system availability, and additional release requirements.

The test data sets in this test plan are simulated because the Landsat 7 satellite will not be launched before the completion of the last test phase. Though the data will come from various sources (GTSIM, Landsat 4/5 data conversion tools, instrument I&T, spacecraft I&T), none is guaranteed to duplicate data that will be received after launch. The results of testing are necessarily limited by the available data.

4.13   System Test Activities Schedule

The following is a generic schedule for system test planning and execution for each LPGS release. The date listed for each item is the COMPLETION date, unless otherwise indicated. All dates are relative to the date of the turnover to System Test. The planned turnover dates will be maintained in the Release Implementation Plan.

Activity	Completion Date
Test case selection	turnover - 8 weeks
Test data identification	turnover - 8 weeks
Test procedures generation	turnover - 5 weeks
Test Procedures Walkthrough	turnover - 4 weeks
Test data generation / verification	turnover - 4 weeks
Test environment setup / cleanup	turnover - 2 weeks
System Test Readiness Review	turnover - 1 week
Dry run of the release	turnover - 1 week
1st turnover from Integration Test	turnover + 0 days
Confidence testing	turnover + 3 days
Last turnover from Integration Test	turnover + 4 weeks
Regression testing before delivery	turnover + 6 weeks
Test execution	turnover + 6 weeks
Delivery package preparation	turnover + 6 weeks
Release to customer	turnover + 6 weeks
Lessons learned meeting	turnover + 7 weeks
Test summary report	turnover + 10 weeks

Section 5 - Configuration and Data Management

Section 5 describes the configuration activities that pertain to the testing phases of the LPGS. The Configuration Management section of the Integration, Test and Software Configuration Department is responsible for configuration control.

5.1   Test Tools

Tools developed for testing the LPGS will be documented (e.g. description, location, release used in) and placed in a configured software library for reuse and access by all LPGS personnel. Changes to the configured test tools will be controlled and tracked by the CM personnel responsible for the maintenance of the configured test tool library.

Test tools will be made available to the operations staff when the LPGS software is released. The tools will be provided as engineering versions and will not be formally delivered. Any modifications made by EDC personnel to the tools are outside the scope of CNMOS test, maintenance, and configuration control.

5.2   Test Data

LPGS test data will be configured and associated with a release baseline, but will not be a deliverable item. CM personnel will be responsible for maintaining a test data catalog and configured test tool library, and any changes to the configured test data will be tracked.

The data catalog will contain information on data characteristics, status, and location; and will be accessible to all LPGS personnel. After test data files have been validated (e.g., it has been determined that they contain the desired characteristics), they will be stored in a common location to allow easy access by multiple groups (i.e., development, integration test, and system test). Some small test data files will be kept on-line to allow quick access. Larger files will be kept on tape and will be stored in CSC's Greentec IV facility in order to maintain configuration control.

5.3   Test Environments

This section describes the configuration of the integration and system test environments. A test environment consists of hardware elements, system software and COTS products including the operating system, database, and interface software not part of the LPGS application software.

5.3.1   Setup and Verification

The test groups, with the support of the System Engineering and System Administration staff, will be responsible for the identification, setup, and verification of their respective test environments.

CM will be responsible for documenting each test environment (i.e., hardware elements and software versions) via a build checklist prior to the start of a test period. The test environment is

always a configured environment and changes to it must be documented and approved via a CCR.

5.3.2   Cleanup and Maintenance

After testing has been completed, the test environment must be prepared for the beginning of the next test phase.

- new regression data should be identified, cataloged, and stored on tape

- all data, files, logs, messages, or mail that support test assessment or problem report analysis should be written to tape or hardcopy, marked with the appropriate reference, and stored

- all other (expendable) data files and log files should be purged from the test baseline

- the baseline database should be archived (by Oracle tool)

- baseline LPGS software should be backed up to tape, along with the database archive. The test group should maintain the current baseline and one previous; tapes from earlier baselines can be recycled

Maintenance of the test environment is the responsibility of the test group. Limitations on test resources may require environment cleanup to be done during the test phase. (i.e., releasing unnecessarily used disk space) to avoid impacts on test execution.

5.4   Software Turnovers

Upon successful completion of the development phase per build, the project CRB will determine if the software for a planned release or a software patch is ready to be promoted to the next phase of testing (i.e. integration test or system test). Once approval is granted an Electronic Software Change Notice will be prepared to transition the software to the next phase.

Upon the receipt of the Electronic Software Change Notice the LPGS Configuration Management Assistant will promote the units to the appropriate test environment, build the executables, install them, and invoke the system. If each step is successful the system will be turned over to the appropriate test manager, upon demonstration that the test team can successfully bring up the system.

5.5   Packaging

The preparation of the delivery package is a team effort involving software development, system engineering, configuration management, integration and system test personnel. A Delivery Agreement Memorandum (DAM) approved by the ATR dictates the contents (i.e., new development and CCRs) of the delivery. The turnover packages (internal deliveries) from a given release become the delivery package draft, which is maintained by the CM group. Before the final document is produced, an internal delivery package review is held to ensure the completeness and accuracy of the contents.

Section 6 - Test Specifications

6.1 Subsystem Interface Test Sets

All test sets for the LPGS subsystem integration and system efforts are described in this section.

The following sections describe the test sets and cases planned for integrating the software subsystems of the LPGS.

6.1.1   I&T Test Set 1 - Process Control Subsystem (PCS)

Integration test set 1 tests the processing paths for managing the subsystems to process LPGS mission operational tasks. This test set includes invocation by the user interface to initiate the processes to plan, monitor, calibrate and evaluate LPGS subsystem operations.

01. To successfully send processing parameters to the GPS subsystem without errors.

02. To successfully receive processing status from the GPS subsystem without error.

03. To successfully send processing parameters to the RPS subsystem without errors.

04. To successfully receive processing status from the RPS subsystem without error.

05. To successfully send QAS processing request to the QAS subsystem without errors.

06. To successfully receive QAS processing status from the QAS subsystem without error.

07. To successfully send DMS processing requests to the DMS subsystem without errors.

08. To successfully receive DMS processing status from the DMS subsystem without error.

09. To successfully accept PCS User Input requests.

10. To successfully send PCS User Output requests.

6.1.2   I&T Test Set 2 - Geometric Processing Subsystem (GPS)

Integration test set 2 tests the processing paths for Level 1G product generation for the Geometric Subsystem (GPS).

01. To successfully store trending data in the LPGS Database.

02. To successfully store L1G image data output files to work order directories.

03. To successfully receive L1R image processing files from work order directories.

04 To successfully send processing status to PCS without errors.

05. To successfully receive ODL processing parameter files from PCS.

REVIEW

6.1.3   I&T Test Set 3 - Radiometric Processing Subsystem (RPS)

The integration test set 3 tests the radiometric processing subsystem used to calibrate the in-flight radiance of each detector. This level 1R processing will convert the brightness of the image pixels to absolute radiance, and is completed prior to geometric processing.

01. To successfully store trending data in the LPGS Database.

02. To successfully store L1R image data output files to work order directories.

03. To successfully receive ODL processing parameter files from PCS.

04 To successfully send processing status to PCS.

05. To successfully receive L0R image processing files from work order directories.

6.1.4   I&T Test Set 4 - Data Management Subsystem (DMS)

The Data Management Subsystem (DMS) is the application used to handle data requests from all other LPGS subsystems. The following are the primary function of DMS and are used to develop interface test cases.

01. To successfully accept DMS User Input requests.

02. To successfully send DMS User Output requests.

03. To successfully receive DMS processing requests from PCS.

04. To successfully send DMS processing status to PCS.

05. To successfully send ECS product requests to PCS.

06. To successfully send Level 0R product requests to ECS.

07. To successfully have ECS retrieve Level 1 product delivery records (PDR) .

08. To successfully have ECS retrieve Level 1 products.

09. To successfully receive Level 0R products from ECS.

10. To successfully retrieve Level 0R product response from ECS.

11. To successfully have ECS retrieve Level 1 product acceptance notice (PAN).

6.1.5   I&T Test Set 5 - Quality Assessment Subsystem (QAS)

The Quality Assessment Subsystem (QAS) is the application used to handle postproduction information about image artifacts and effects. The following are the primary functions of QAS that are used to develop interface test cases.

01. To successfully receive QAS L1R and L1G ODL processing parameter files PCS.

02 To successfully send QAS L1R and L1G processing status to PCS.

03. To successfully process user inputs for displaying any single band of L1R or L1G image.

04. To successfully process user input for displaying L1 image quality status and statistics.

05. To successfully process user output request for color hardcopys, of any band of the L1R or L1G image for visual quality assessment.

06. To successfully process user output request for print outs of L1 digital image quality status and statistics.

07. To successfully send QAS results (L1R / L1G) to the LPGS database.

6.1.6   I&T Test Set 6 - Anomaly Analysis Subsystem (AAS)

The Anomaly Assessment Subsystem (AAS) is a set of integrated COTS applications used to handle anomaly analysis.

01. To provide Anomaly Analysis reports for the ECS trouble ticket system (remedy).

02. To successfully respond to trouble tickets from ECS.

6.2   System Test Sets

The following section describes the test sets and cases planned for system testing of the LPGS. Because the test cases are grouped by logical sets, expected output and resources required to test are defined on the test set level. When required for clarification, details are included at the test case level.

6.2.1   System Test Set 1.0 - Nominal Processing

The following describes the test sets and cases planned for system testing of the LPGS during a nominal processing flow. Nominal processing for LPGS is product ingest of radiometric and geometric correction, quality assessment, formatting and distribution, all intended to be performed in an automatic manner, without operator intervention.

6.2.1.1   System Test Set 1.1 - System Monitoring and Data Management

Purpose: To ensure that the user can monitor the operational process and provide operational control.

Description: This test set verifies that the LPGS provides display and messages to indicate progress and status of software. The LPGS operator can start up the software, change certain configuration parameters, override automated functions, and display statistical information.

Expected Output:

- Information Messages

- Alarm Messages

REVIEW

- Operator can alter order in processing queue

- Operator can monitor certain process

Resources Required:

- User Interface (UI)

- Process Control Subsystem (PCS)

- Radiometric Processing Subsystem (RPS)

- Geometric Processing Subsystem (GPS)

- Quality Assessment Subsystem (QAS)

- Anomaly Assessment Subsystem (AAS)

- Data Management Subsystem (DMS)

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.1.1 3.1.9 3.2.2.1 3.3.6.1	1.00	Verify LPGS can generate Level 1 digital output images.	
3.1.1 3.1.9 3.2.2.1 3.3.6.1 3.3.6.1.1	1.01	Verify LPGS can generate Level 1 digital output images in HDF-EOS unencapsulated formats (L1R and L1G).	
3.1.1 3.1.9 3.2.2.1 3.3.6.1 3.3.6.1.2	1.02	Verify LPGS can generate Level 1 digital output images in EOSAT FAST-C (L1G Only) format.	
3.1.1 3.1.9 3.2.2.1 3.3.6.1 3.3.6.1.3	1.03	Verify LPGS can generate Level 1 digital output images in GeoTiFF (L1G Only) format.	
3.1.1 3.2.2.1 3.3.6.2	1.04	Verify LPGS capability to transfer L1 files to ECS.	
3.1.1 3.3.6.3	1.05	Verify the capability to display LPGS Level 1 file transfer summary upon operator request.	

F&PRS Req.	Test Case	Test Description	Additional Results
3.1.9 3.2.2.1 3.3.6.4	1.06	Verify LPGS capability to detect files which have been successfully transferred.	
3.1.1 3.3.6.5	1.07	The LPGS shall be able to mark successfully transferred files as candidates for deletion from LPGS temporary storage.	
3.2.2.1 3.3.7.2	1.08	Verify the capability to retransmit L1 Products to the ECS for files located in temporary storage.	
3.3.8.1	1.09	Verify operators capability to select thresholds for statistics and errors reported by the LPGS.	
3.1.5 3.3.8.2	1.10	Verify the capability to generate messages and alarms to alert the operator of LPGS results and errors exceeding operator-selected thresholds.	
3.3.8.3	1.11	Generate LPGS intermediate processing summaries on a periodic basis.	
3.3.8.4	1.12	Verify the capability to display Level 1 digital image quality status and statistics at operator request.	
3.3.8.5	1.13	Verify the capability to print Level 1 digital image quality status and statistics at operator request.	
3.3.8.6	1.14	Verify LPGS capability to manually override the LPGS automated processing functions.	
3.3.8.7	1.15	Verify LPGS capability to manually cancel Level 1 processing prior to completion of digital image generation.	
3.3.8.8	1.16	Verify LPGS capability to display and print trouble tickets received from ECS	
3.3.8.3 3.3.8.4 3.3.8.5	1.17	Verify LPGS operator's Graphic User Interface ("System ") capabilities.	
3.3.8.3 3.3.8.4 3.3.8.5	1.18	Verify LPGS operator's Graphic User Interface ("Product Request") capabilities	
3.3.8.3 3.3.8.4 3.3.8.5	1.19	Verify LPGS operator's Graphic User Interface ("Anomaly Analysis") capabilities	
3.3.8.3 3.3.8.4 3.3.8.5	1.20	Verify LPGS operator's Graphic User Interface ("Quality Assessment") capabilities	
3.3.8.3 3.3.8.4 3.3.8.5	1.21	Verify LPGS operator's Graphic User Interface ("Monitor ") capabilities.	

6.2.1.2   System Test Set 1.2 - Product Request Control and Generation

Purpose: To ensure that a user can setup and modify product requests for Level 1 processing.

REVIEW

Description: This test defines the user ability to establish product request used to ingest level 0R data products, and request radiometric and geometric processing.

Expected Output:

- Queue of Work Orders submitted

- Operator alarms on the console

- Payload Correction Data (PCD) file from L0R ingest process

- Mirror Scan Correction Data (MSCD) file from L0R ingest process

- Image Data

- Work Order Log

- All output files are correct and reside in the correct directory

Resources Required:

- User Interface (UI)

- Process Control Subsystem (PCS)

- Radiometric Process Subsystem (RPS)

- Geometric Process Subsystem (GPS)

- Data Management Subsystem (DMS)

- Quality Assessment Subsystem (QAS)

- Anomaly Assessment Subsystem (AAS)

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.1.2	2.00	Verify LPGS capability to move a product request order within the FIFO queue according to operator direction	
3.1.16 4.2.3	2.01	Verify LPGS capability to acknowledge L0R product receipt.	
3.3.7.5 3.3.8.3	2.02	Verify LPGS capability to display product request information at operators request.	
3.1.5 3.3.8.2	2.03	View alarms and alerts on all product request processed.	
3.1.16 3.3.8.3	2.04	Create a product request using a pre-defined form for processing a Level 0R product through radiometric processing only.	

F&PRS Req.	Test Case	Test Description	Additional Results
3.2.1.1 3.3.1.1	2.05	Setup a product request that allows for automatic ingesting of Level 0R data during the year 2000.	
3.2.1.1 3.3.1.1	2.06	Setup a product request which allows ingesting and processing of data spanning the boundary from December 31, 1999 to January 1, 2000.	
3.2.1.1 3.3.1.1	2.07	Setup a product request which allows ingesting and processing of data spanning the boundary from February 28, 2000 to February 29, 2000 and ending on February 29, 2000.	
3.2.1.1 3.3.1.1	2.08	Setup a product request which allows ingesting and processing of data entirely within February 29, 2000.	
3.2.1.1 3.3.1.1	2.09	Setup a product request which allows ingesting and processing of data spanning the boundary from February 29, 2000 to March 1, 2000 and beginning on February 29, 2000.	
3.2.1.1 3.3.1.1	2.10	Setup a product request which allows ingesting and processing of data spanning the boundary from February 29, 2000 to March 1, 2000 and ending on March 1, 2000.	
3.2.1.1 3.3.1.1	2.11	Setup a product request which allows ingesting and processing of data spanning the boundary from December 30, 2000 to December 31, 2000 and ending on December 31, 2000.	
3.2.1.1 3.3.1.1	2.12	Setup a product request which allows ingesting and processing of data spanning the boundary from December 31, 2000 to January 1, 2001 and beginning on December 31, 2000.	
3.2.1.1 3.3.1.1	2.13	Setup a product request which allows ingesting and processing of data entirely within December 31, 2000.	
3.2.1.1 3.3.1.1	2.14	Setup a product request which allows ingesting and processing of data spanning the boundary from December 31, 2000 to January 1, 2001 and ending on January 1, 2001	
3.2.1.1 3.3.1.1	2.15	Setup a product request which allows ingesting and processing of data beginning and ending in year 2001	
3.1.21 3.3.1 4.2.1	2.16	Verify LPGS capability to setup a product request which allows a data volume equivalent to three WRS scenes worth of standard L0R data spanning the time boundary from December 31, 1999 to January 1, 2000.	

6.2.1.3   System Test Set 1.3 - Work Order Control and Generation

Purpose: To ensure that a user can create and modify work orders for Level 1 processing.

Description: This test defines the user ability to establish work orders used to ingest level 0R data products, perform "what IF" analysis, and request calibration and characterization for the radiometric and geometric processes.

Expected Output:

- Queue of Work Orders submitted

REVIEW

- Operator alarms on the console

- Payload Correction Data (PCD) file from L0R ingest process

- Mirror Scan Correction Data (MSCD) file from L0R ingest process

- Image Data

- Work Order Log

- All output files are correct and reside in the correct directory

Resources Required:

- User Interface (UI)

- Process Control Subsystem (PCS)

- Radiometric Process Subsystem (RPS)

- Geometric Process Subsystem (GPS)

- Data Management Subsystem (DMS)

- Quality Assessment Subsystem (QAS)

- Anomaly Assessment Subsystem (AAS)

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.2.1 3.2.2 3.3.1.1	3.00	Generate a work order using a pre-defined Oracle forms.	
3.2.1 3.2.2 3.3.1.1	3.01	Create a work order using a pre-defined Oracle form for processing Level 0R data products from ECS.	
3.1.16 3.3.8.3	3.02	Create a work order using a pre-defined form for processing a Level 0R product through radiometric processing only.	
3.1.16 3.3.8.3	3.03	Review the status of any work order submitted for processing	
3.3.8.3 3.3.8.5	3.04	Generate a work orders which will allow the reporting of activities after level 1R, or 1G processing	
3.1.5 3.3.8.2	3.05	View alarms and alerts on all work orders processed.	
3.1.5 3.3.8.2	3.06	Selectively view alarms and alerts that required immediate action from the user.	
3.1.2 3.1.16	3.07	Verify that the (UI) will allow a user to review the current status of a work order.	

F&PRS Req.	Test Case	Test Description	Additional Results
3.1.16	3.08	Create a work order using default parameters for all non mandatory fields.	
3.1.16	3.09	Create a product request to monitoring database quires from IAS for characterization results.	
3.1.16	3.10	Create a work order which will result in radiometric processing only.	
3.1.16	3.11	Create a work order which will result in geometric processing only.	
3.3.8.3	3.12	Create a work order which will perform radiometric processing on Day Scene images.	
3.3.8.3	3.13	Create a work order which will perform radiometric processing on Night Scene images.	
3.3.8.3	3.14	Create a work order which will perform radiometric processing on MTF Scene	
3.3.8.3	3.15	Create a work order to request radiometric processing overriding random noise default parameters.	
3.3.8.3	3.16	Create a work order to request radiometric processing overriding default parameter for detector inoperability.	
3.3.8.3	3.17	Create a work order to request radiometric processing and overriding detector saturation parameters.	
3.3.8.3	3.18	Create a work order to request radiometric processing and override detector temperature.	
3.1.16 3.3.8.3	3.19	Modify any work order parameters before execution and verify the corrections were applied to the work order as specified.	
3.1.16 3.3.8.3	3.20	Create a work order with multiple shell scripts which define a process for executing, pausing and resuming the process.	
3.1.2	3.21	Verify LPGS capability to move a Level 1 image processing work order within the FIFO queues according to operator direction.	
3.2.1.1 3.3.1.1 4.2.1	3.22	Setup a work order which allows a data volume equivalent to three WRS scenes worth of standard L0R data spanning the time boundary from December 31, 1999 to January 1, 2000.	
3.2.1.1 3.3.1.1 4.2.2	3.23	Setup a work order which allows the capability to transfer to ECS the equivalent of a minimum of 25 WRS sized level 1 digital images per day spanning the time frame from February 28, 2000 to February 29, 2000 and ending on February 29, 2000.	
3.2.1.1 3.3.1.1	3.24	Setup a work order which allows 33 Gbytes of Level 1 images processed for entirely within February 29, 2000.	

6.2.1.4   System Test Set 1.4 - Radiometric Processing

Purpose: To ensure that the LPGS can perform level 1R processing.

REVIEW

Description: This test process radiometric calibration functions to determine the in-flight calibration of each detector. The level 1 process converts the brightness of the image pixels to absolute radiance. This process uses various ground and in-flight determined calibrations.. The level 1R characterize various features of the data.

Expected Output:

- Information Messages

- L1R image data

- Operator alarms on the console

Resources Required:

- User Interface (UI)

- L0R image data

- Process Control Subsystem (PCS)

- Radiometric Process Subsystem (RPS)

- Data Management Subsystem (DMS)

- Quality Assessment Subsystem (QAS)

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.2.3	4.00	Verify LPGS capability to interface with the Image Assessment System (IAS) to provide Level 1 radiometric characterization data.	
3.3.4.1	4.01	Verify LPGS capability to generate ancillary L1R digital image data that describes the contents, processing parameters, and quality indicators of the L1R digital image.	
3.3.2	4.02	Verify LPGS capability to extract and process Landsat 7 ETM+ Earth image data from the L0R Earth image data file to produce radiometrically corrected L1R digital images.	
3.3.2.1	4.03	Verify LPGS capability to extract and process attitude and ephemeris data from the L0R Payload Correction Data (PCD) files.	
3.3.2.2	4.04	Verify LPGS capability to extract parameters from the L0R internal calibrator or calibration parameter file for use in L1R and L1G processing.	
3.3.2.3	4.05	Verify LPGS capability to generate gains and biases from either the internal calibrator data or from the calibration parameter file. The default shall be the calibration parameter file	

REVIEW

F&PRS Req.	Test Case	Test Description	Additional Results
3.3.2.4	4.06	Verify LPGS capability to extract and process mirror scan correction coefficients from the L0R MSCD file to determine scan line quality.	
3.3.2.5 3.3.2.5.1 3.3.2.5.2 3.3.2.5.3 3.3.2.5.5 3.3.2.5.6 3.3.2.5.7	4.07	Verify LPGS capability to detect the following image artifacts: Striping, Banding, Coherent noise, Scan-correlated shift, Saturated detectors, Dropped scan lines	
3.3.2.6 3.3.2.6.1 3.3.2.6.2 3.3.2.6.3 3.3.2.6.6 3.3.2.6.7	4.08	Verify LPGS capability to characterize image artifacts for: Striping, Banding, Coherent noise, Saturated detectors, Dropped scan lines	
3.3.2.7 3.3.2.7.1 3.3.2.7.2 3.3.2.7.3 3.3.2.7.4 3.3.2.7.5 3.3.2.7.6 3.3.2.7.7 3.3.2.7.8	4.09	Verify LPGS capability to apply compensation for image artifacts: Striping, Banding, Coherent noise, Memory effect, Scan-correlated shift, Inoperable detectors, Saturated detectors, Dropped scan lines.	
3.3.2.8	4.10	Verify LPGS capability to apply compensation for gain changes within a requested L1 scene or subinterval as identified in the Level 0 metadata.	
3.1.1 3.3.2.9	4.11	Verify LPGS capability to produce L1R data from L0R data for both the ascending and descending portions of the Landsat 7 orbit.	
3.3.2.10	4.12	Verify LPGS capability to produce L1R digital images for any combination of the eight spectral channels.	
3.3.2.11	4.13	Verify LPGS capability to assemble and append to the L1R digital images all of the applicable metadata, quality and accounting data gathered in the construction of the L1R digital image.	
3.3.2.11.1 3.3.2.11.2	4.14	Verify LPGS capability to assemble and append Level 1R digital image (all requested bands), and Level 1 metadata file.	
3.3.4.3	4.15	Verify LPGS capability to generate and append processing summary indicators specifying the algorithms applied to the Level 1 digital images.	

F&PRS Req.	Test Case	Test Description	Additional Results
4.1.2	4.16	Verify LPGS capability to contribute no greater than .7 percent uncertainty to absolute radiometric accuracy during the generation of L1R digital images.	

6.2.1.5 System Test Set 1.5 - Quality Assessment Processing

Purpose: To ensure that LPGS can generate and assemble postproduction information about image artifacts and effects.

Description: This test demonstrates the QAS capability to display ASCII and image files, provide statistical analysis of the outputs from radiometric and geometric correction and characterization processes, and generate reports.

Expected Output:

- Information Messages
- Alarm Messages

Resources Required:

- User Interface (UI)
- Process Control Subsystem (PCS)
- Radiometric Processing Subsystem (RPS)
- Geometric Processing Subsystem (GPS)
- Quality Assessment Results (QAS)
- L1 Processing Images

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.3.5.1	5.00	Verify LPGS capability to support automatic assessment of L1 digital image quality.	
3.3.5.2	5.01	Create a work order to display any single band of the L1R digital image for visual quality assessment	
3.3.5.3	5.02	Create a work order to display any single band of the L1G digital image for visual quality assessment	
3.3.5.4	5.03	Create a work order to optionally print a black and white or color copy for any band(s) of L1R digital image for visual quality assessment	

F&PRS Req.	Test Case	Test Description	Additional Results
3.3.5.5	5.04	Create a work order to optionally print a black and white or color copy for any band(s) of L1G digital image for visual quality assessment	
4.1.3	5.05	Verify LPGS capability to contribute circular errors no greater than 1.8 m, 1 sigma, in the production of systematically corrected L1G digital images	
3.3.5.1 3.3.8.1	5.06	Create a work order to search for radiometric or geometric corrected images that failed QAS thresholds.	

6.2.1.6   System Test Set 1.6 - Geometric Processing

Purpose: To ensure that imagery from L0R data is systematically corrected for L1G images.

Description: This test defines the LPGS and user capabilities to establish and maintain functionality required for systematically corrected Level 1G image data.

Expected Output:

- Information Messages

- L1G image data

- Database Updates

- Trending Database report

- Operator alarms on the console

Resources Required:

- User Interface (UI)

- Process Control Subsystem (PCS)

- Data Management Subsystem (DMS)

- Radiometric Processing Subsystem (RPS)

- Geometric Processing Subsystem (GPS)

- Quality Assessment Subsystem (QAS)

- L1R image data

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results

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F&PRS Req.	Test Case	Test Description	Additional Results
3.3.4.2	6.00	Verify LPGS capability to generate ancillary L1G digital image data that describes the contents, processing parameters, and quality indicators of the L1G digital image.	
3.3.3	6.01	Verify LPGS capability to extract and process Landsat 7 ETM+ Earth image data from the L1R Earth image data files to produce systematically corrected L1G digital images.	
3.3.3.1 3.3.3.1.1 3.3.3.1.2 3.3.3.1.3 3.3.3.1.4 3.3.3.1.5 3.3.3.1.6 3.3.3.1.7	6.02	Verify LPGS capability to resample L1R digital images and apply the following map projections: Space Oblique Mercator (SOM), Universal Transverse Mercator (UTM), Lambert Conformal Conic (LCC), Transverse Mercator (TM), Oblique Mercator (OM), Polyconic(PC), Polar Stereographic (PS).	
3.3.3.2 3.3.3.2.1 3.3.3.2.2 3.3.3.2.3	6.03	Verify LPGS capability to provide compensation resampling methods for: Nearest neighbor (NN), Cubic convolution (CC), Modulation Transfer Function (MTF).	
3.3.3.3 3.3.3.3.1 3.3.3.3.2	6.04	Verify LPGS capability to produce L1G digital images with the following grid cell characteristics: Grid cell size is variable from 15M to 60M in 0.001M increments Grid cell size is independently variable between spectral bands	
3.3.3.4	6.05	Verify the capability to produce L1G digital images that are spatially continuous between contiguous partial subintervals or WRS scenes.	
3.3.3.5 3.3.3.5.1 3.3.3.5.2	6.06	Verify LPGS capability to generate L1G digital images oriented by the following: Nominal Path, North Up	
3.3.3.6	6.07	Verify LPGS capability to producing L1G data from L0R data for both the ascending and descending portions of the Landsat 7 orbit.	
3.3.3.7	6.08	Verify LPGS capability to produce L1G digital images for any combination of the eight spectral channels.	
3.3.3.8 3.3.3.8.1 3.3.3.8.2	6.09	Verify LPGS capability to assemble and append to the L1G digital images all applicable metadata, quality and accounting data gathered in the construction of the L1G digital image. Level 1G digital image (all requested bands), and L1 Metadata files	
3.3.4.3	6.10	Verify LPGS capability to generate and append processing summary indicators specifying the algorithms applied to the Level 1 digital images.	
4.1.2	6.11	Verify LPGS capability to contribute no greater than .7 percent uncertainty to absolute radiometric accuracy during the generation of L1R and L1G digital images.	

F&PRS Req.	Test Case	Test Description	Additional Results
4.1.3	6.12	Verify LPGS capability to contribute circular errors no greater than 1.8 m, 1 sigma, in the production of systematically corrected L1G digital images	

6.2.2   System Test Set 2.0 - Non-nominal Processing

The following describes the test sets and cases planned for system testing of the LPGS during a Nonnominal processing flow. Non - nominal processing for LPGS is mainly anomaly analysis for radiometric and geometric correction, quality assessments and customer problem reporting.

6.2.2.1   System Test Set 2.1 - Anomaly Analysis Processing

Purpose: To ensure that the user can analyze and resolve LPGS production type anomalies. Also, file editing and report generation capabilities.

Description: This test defines the LPGS and user capabilities to establish and maintain functionality required for Anomaly Analysis processing.

Expected Output:

- Information Messages
- Alarms and Messages on console
- Anomaly Reports
- Corrected L1 Products
- Trouble Tickets Responses

Resources Required:

- User Interface (UI)
- Process Control Subsystem (PCS)
- Radiometric Processing Subsystem (RPS)
- Geometric Processing Subsystem (GPS)
- Data Management Subsystem (DMS)
- Quality Assessment Subsystem (QAS)
- L1R image data
- L1G image data

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.1.13	7.00	Verify LPGS capability to execute diagnostic tests for verifying proper operation of system capabilities and components.	
3.1.14	7.01	Verify LPGS capability to support end-to-end testing of Level 1 processing functions.	
3.1.16	7.02	Verify LPGS capability to monitor LPGS operations.	
3.3.5.2	7.03	Verify LPGS capability to optionally display any single band of the L1R digital image for visual quality assessment	
3.3.5.3	7.04	Verify LPGS capability to optionally display any single band of the L1G digital image for visual quality assessment.	
3.3.5.4	7.05	Verify LPGS capability to optionally print a color hard copy of the display of any band(s) of the L1R digital image for visual quality assessment	
3.3.5.5	7.06	Verify LPGS capability to optionally print a color hard copy of the display of any band(s) of the L1G digital image for visual quality assessment.	
3.3.6.3 3.3.8.4	7.07	Verify capability to view any file related to a product request with anomaly.	
3.3.8.3	7.08	Verify the capability to change work order parameters and submit work order to resolve anomaly.	
3.3.8.3	7.09	Verify the capability to generate a benchmark work order to test source of anomaly.	
3.3.8.3	7.10	Verify the capability to add anomaly to anomaly status table.	
3.3.8.3	7.11	Verify the capability to close out anomaly after successful processing of product request or work order.	

6.2.3   System Test Set 3.0 - Cancellation & Recovery Processing

Purpose: To ensure that a user can perform cancellation of product request, work orders and recover from systems operation during scheduling and processing of product request.

Description: This test defines the LPGS and user capabilities to establish and maintain functionality for clean-up and deletion of interim files and products that relate to the canceled product generation requests.

Expected Output:

- Information/Status Messages
- Alarm Messages
- Operator can override priority of work order

Resources Required:

- Information Messages (Verbal communication)
- E-mail

- User Interface (UI)

- Process Control Subsystem (PCS)

- Radiometric Subsystem (RPS)

- Geometric Subsystem (GPS)

- Data Management Subsystem (DMS)

- Quality Assessment Subsystem (QAS)

- Anomaly Assessment Subsystem (AAS)

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.3.8.7	8.00	Verify LPGS capability to cancel a product request.	
3.3.8.7	8.01	Verify LPGS capability to cancel a work order.	
3.3.8.7	8.02	Verify the capability to cancel/pause a product request loaded by tape.	
3.15 3.1.6	8.03	Verify the capability to facilitate the detection and correction of abnormal system conditions	
3.3.8.6	8.04	Verify the capability to manually override the LPGS automated processing functions.	
3.3.8.7	8.05	Verify the manual capability to cancel Level 1 processing prior to completion of digital image generation.	
3.1.22	8.06	Verify LPGS capability to recover from failures and aborts in a controlled manner.	

6.2.4   System Test Set 4.0 - Data Receipt from External Interfaces

Purpose: To ensure that the LPGS can retrieve L0 products from external interfaces and store the data on a permanent media for later use.

Description: This test demonstrates the capability to receive Level 0R data from ECS.

Expected Output:

- Automatically start data receipt and store the data products in temporary directory before permanent file assignments.
- Data transferred through the ECS interface and LPGS DMS subsystem
- Data received remains unchanged during data transfer.
- DMS receives data without terminate until complete data receipt or manual end of process.
- Operator alarms on the console
- Transfer problems are resolved by operator intervention

REVIEW

- All output files are correct and reside in the correct directory

Resources Required:

- User Interface (UI)
- Data Management Subsystem (DMS)
- TCP Session

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.2.1 3.3.1.1	9.00	Verify LPGS capability to interface with the ECS.	
3.2.1 3.3.1 3.2.1.1	9.01	Verify LPGS capability to interface with the ECS to receive L0R files PCD, MSCD, and CPF.	
3.2.1 3.2.1.2	9.02	Verify LPGS capability to interface with the ECS to receive Level 1 image processing requests.	
3.2.1 3.2.1.3	9.03	Verify LPGS capability to interface with the ECS to receive Data Availability Notification (DAN).	
3.2.1 3.2.1.4	9.04	Verify LPGS capability to interface with the ECS to receive Production status requests.	
3.2.1 3.2.1.5	9.05	Verify LPGS capability to interface with the ECS to receive Product cancellation requests.	
3.2.1 3.2.1.6 3.3.1.1.6 3.3.8.8	9.06	Verify LPGS capability to interface with ECS to receive trouble ticket.	
3.2.1 3.3.1 3.3.1.1	9.07	Verify the capability to receive LPGS L0R data inputs from ECS using a daily/weekly work order script.	
3.2.1 3.3.1 3.3.1.1.1	9.08	Verify the capability to receive Level 1 image processing request from ECS.	
3.3.1 3.3.1.1.1a	9.09	Verify the capability to select coordinated reference system for map projection.	
3.3.1 3.3.1.1.1b	9.10	Verify the capability to select orientation (nominal path or north up).	
3.3.1 3.3.1.1.1c	9.11	Verify the capability to request variable grid cell size selection from ECS.	
3.3.1 3.3.1.1.1d	9.12	Verify the capacity to generate output format selection.	

3.3.1 3.3.1.1.1e	9.13	Generate a request for resampling filter data.	
3.3.1 3.3.1.1.1f	9.14	Generate a product request for selected band(s).	
3.3.1 3.3.1.1.1g	9.15	Generate a product request for selected scene or subinterval identification.	
3.3.1 3.3.1.1.1h	9.16	Generate a product request to request L1R or L1G image processing selection.	
3.3.1 3.3.1.1.1i	9.17	Generate a product request to request a Geographic area.	
3.2.1 3.3.1 3.3.1.1.1j	9.18	Verify the capability to request WRS (path/row) scene identifiers.	
3.2.1 3.3.1 3.3.1.1.1k	9.19	Verify the capacity to receive Internal calibrator (IC) or Calibration Parameter File (CPF) (default = CPF) from ECS.	
3.3.1 3.3.1.1.2	9.20	Generate a Production Availability Notification specifying the location of associated L0R product files ready for transfer.	
3.2.1 3.3.1 3.2.1.1 3.3.1.1.3	9.21	Verify the capability to request L0R product files (includes L0R image data, PCD, MSCD and associated Calibration files [internal calibrator and calibration parameter files]) from ECS.	
3.2.1 3.3.1 3.3.1.3.1	9.22	Verify LPGS can detect data transfer problems from ECS.	
3.2.1 3.3.1 3.3.1.3.2	9.23	Verify LPGS capability to reorder data from ECS.	
4.21	9.24	Verify the LPGS capability to ingest from ECS a data volume equivalent to three WRS scenes worth of standard L0R data for each Level 1 digital image request.	

6.2.5 System Test Set 5.0 - Data Transfer to External Interfaces

Purpose: To ensure that the LPGS can send reports and data files to ECS and IAS.

Description: This test demonstrates the capability to transfer Characterization results to IAS and transfer Level 1 products and request L0R data from ECS as requested. For file transfer with errors, a manually intervention procedure will need to implemented to complete the successful transfer of data files to the site.

Expected Output:

REVIEW

- Data transfers through the DMS subsystem to external interfaces (ECS & IAS).
- Operator alarms on the console
- Characterization Results
- L1 Products
- Transfer problems are resolved by operator intervention
- All output files are correct and reside in the correct directory

Resources Required

- User Interface (UI)
- Data Management Subsystem (DMS)
- TCP Session

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.2.1 3.2.2.1	10.00	Verify LPGS capability to interface with the ECS to coordinate the transfer of LPGS L1 digital images.	
3.2.2.2 3.2.2.3 3.2.2.4	10.01	Verify LPGS capability to interface with the ECS to coordinate the transfer of Processing status, and L1 processing statistics .	
3.2.2.5 3.2.2.6 3.2.2.7	10.02	Verify LPGS capability to interface with the ECS to coordinate the transfer of L1 metadata, PCD file (consensus), and MSCD file (consensus).	
3.2.2.8	10.03	Verify LPGS capability to interface with the ECS to coordinate the transfer of IC data file.	
3.2.2.9	10.04	Verify LPGS capability to interface with the ECS to coordinate the transfer of CPF.	
3.2.2.10	10.05	Verify LPGS capability to interface with the ECS to coordinate the transfer of Geolocation table.	
3.2.3	10.06	Verify the capability to interface with the Image Assessment System (IAS) to provide Level 1 radiometric characterization data.	
3.3.1.2	10.07	Verify the capability to create and send L0R product requests to the ECS.	
4.2.2	10.08	Verify the capability to support the transfer to ECS of the equivalent of a minimum of 25 WRS sized Level 1 digital images per day.	
4.2.3	10.09	Verify the capability to transfer to the ECS at least 25 scenes (33 Gbytes) of Level 1 output files per day.	

6.2.6　System Test Set 6.0 - LPGS Report Generation

Purpose: To ensure that LPGS can generate reports/summaries and data files for quality assessments and analysis.

Description: This test demonstrates the capability to generate reports/summaries and quality assessments. The test verifies that data capture during the major processes are accurate and reflected in the reports/summaries as requested.

Expected Output:

- Reports/Summaries contain all data required as expected
- User can request reports for display
- User can request reports for printers

Resources Required:

- User Interface (UI)
- Data Management Subsystem (DMS)
- Quality Assessment Subsystem (QAS)
- Radiometric Processing Subsystem(RPS)
- Geometric Processing Subsystem(GPS)

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.3.2.5.7 3.3.2.6.7 3.3.2.7.8	11.00	Generate a radiometric report that characterizes dropped lines.	
3.3.2.7.4	11.01	Generate a radiometric report that characterizes memory effects.	
3.3.2.5.5 3.3.2.7.5	11.02	Generate a radiometric report that characterizes Scan Correlated shifts.	
3.3.2.5.3 3.3.2.6.3 3.3.2.7.3	11.03	Generate a radiometric report that characterizes Coherent Noise.	
3.3.2.5.6 3.3.2.6.6 3.3.2.7.7	11.04	Generate a radiometric report that characterizes Detector Saturation.	
3.3.3.2.3	11.05	Generate a geometric report using compensation resampling for Modulation Transfer Function (MTF).	

3.3.2.5.1 3.3.2.5.2 3.3.2.6.1 3.3.2.6.2 3.3.2.7.1 3.3.2.7.2	11.06	Generate a radiometric report that characterizes Striping and Banding..	
3.3.8.3 3.3.8.5	11.07	Generate summaries that allows analyst to evaluate LPGS data quality on a periodically basis (Monthly / Annually).	
3.3.8.3 3.3.8.4 3.3.8.5	11.08	Generate a summary that allows analyst to evaluate Level 1R data quality on a periodically basis (Monthly / Annually).	
3.3.8.3 3.3.8.4 3.3.8.5	11.09	Generate summaries that allows analyst to evaluate Level 0R data and products daily.	
3.3.8.3 3.3.8.4 3.3.8.5	11.10	Generate selected trend products that allows analyst to evaluate data capture, radiometric, geometric and other processes.	

6.2.7   System Test Set 7.0 - LPGS Performance Processing

Purpose: To ensure that Level 0R products are processed and also, ensure Level 1G and Level 1R digital images are accurate within allowed specification.

Description: This test set verifies the performance of sub-functions for L0R products and L1 Geometric and L1 Radiometric digital images.

Expected Output:

- Information Messages
- Alarm Messages
- L1R digital Image
- L1G digital Image

Resources Required:

- User Interface (UI)
- Process Control Subsystem (PCS)
- Radiometric Processing Subsystem(RPS)
- Geometric Processing Subsystem (GPS)
- Data Management Subsystem (DMS)
- Quality Assessment Subsystem (QAS)

Test Method:

F&PRS Req.	Test Case	Test Description	Additional Results
3.1.21 4.1.1	12.00	Verify the tools for LPGS capability to process a volume of data equivalent to 28 (accounts for 10 percent LPGS internal reprocessing) standard L0R WRS scenes to Level 1 digital images each day.	
4.1.2	12.01	Verify the tools for LPGS capability to contribute no greater than .7 percent uncertainty to absolute radiometric accuracy during the generation of L1R and L1G digital images.	
4.1.3	12.02	Verify the tools for LPGS capability to contribute circular errors no greater than 1.8 m, 1 sigma, in the production of systematically corrected L1G digital images.	
4.1.8	12.03	Verify the tools for LPGS capability to produce Level 1G products that are accurate to within 250 meters cross track and 250 meters along track using geometric calibration information generated by IAS and contained in the associated calibration parameter file.	
4.1.9	12.04	Verify the tools for LPGS capability to register pixels from a band to the corresponding pixels of the other bands in a common scene to an accuracy of 0.28 sensor GSD, 0.9p, in along-track and cross-track directions, providing all inputs are within specification. The accuracy is relative to the largest sensor GSD of the registered bands.	
3.1.17	12.05	Verify LPGS capability to reconfigure system resources.	

6.3 System Integration Test Set

Purpose: System Integration Tests are intended to verify the LPGS as an operational system. Interfaces with ECS and IAS are intended to be run with the hardware and software of the actual facilities.

6.3.1 System Integration Test Set 1.0 - Operational Scenarios and Procedures

F&PRS Req.	Test Case	Test Description	Additional Results
3.1.13 3.1.18	S1.00	Setup/Install LPGS operational software on the operational system.	
3.1.13	S1.01	Setup/Install LPGS operational software on the test system while	

		LPGS operational system is in place.	
3.1.13	S1.02	Perform maintenance on the test system without impacting the operational system.	
3.1.19	S1.03	Archive operational software and data without impacting operations to tape.	
3.1.19	S1.04	Archive a maintenance version of the software from the test system to tape.	
3.1.15 3.1.16	S1.05	Startup LPGS software on the test system.	
3.1.15 3.1.16	S1.06	Verify all required tasks were initiated.	
3.1.14 3.1.20	S1.07	Perform "what if" scenarios on a work order.	
3.1.18	S1.08	Evaluate processing results for accuracy and performance.	
3.3.4.3	S1.09	Generate radiometric calibrations accuracy and summary reports	
3.3.4.3	S1.10	Generate geometric calibration accuracy and summary reports.	
3.3.8.3 3.3.8.4	S1.11	Generate L1 digital image quality statistics and processing summaries.	
3.3.5.1	S1.12	Evaluate quality reports for accuracy.	
3.3.7.5	S1.13	Display scene image.	
3.3.5.4 3.3.7.5	S1.14	Print scene image.	
3.1.5 3.1.6 3.1.17 3.3.8.2	S1.15	Create a multiple product request to increase system resource beyond thresholds to invoke alarms	

Section 7 - Test Resource Requirements

7.1   Test Environment

The following subsections describe the hardware and software configurations from which testing will be performed.

7.1.1   Hardware Configuration

The system administrator will set up and configure all LPGS hardware elements, including system software, for the test environment. Some tests will require access to hardware located at GSFC (e.g. tape drives) and consequently will be executed at GSFC. Each tester will require simultaneous access to a separate Xterminal.

7.1.2   Software configuration

Separate software environments will be established for each of the test groups. Executable software for each build will be located in separate directory structures and the individual test groups will be able to concurrently execute tests using the software in these directories. Each test group will also have a separate database instance. The development organization will provide a set of "suggested" initial values for all static database tables. These values will be changed by the test groups as necessary to conduct the tests. After the initial static values have been loaded, the contents of the database instances will be maintained by the individual test groups.

7.2   Test Tools

Test tools will be used wherever possible to automate and support the test effort. The following subsections describe details of the test tools that are planned.

7.2.1   Drivers and Stubs

A driver will be required to simulate transfer of data from the ECS. A simulator will be required to verify the Production Availability Notice (PAN) and Data Availability Notice (DAN) exchange process. This simulator will receive PANs, validate PANs, and return Data transfer acknowledgments. The simulator will have the capability to either automatically send a valid acknowledgment or to send a data transfer acknowledgment with predefined errors.

During integration testing, stubs and drivers will be required to simulate subsystems that have not yet been developed.

7.2.2   Data Dump and Analysis

The following data dump tools will be developed to assist in the analysis of test output:

Tool	Description
Sync dump	The sync dump tool will produce both frame-synchronized and non-

	synchronized dumps of up to 10 CADUs of input data.
Band file dump	The band file dump tool will allow the user to choose whether a summary dump or a full dump is desired for a range of scan lines. If a summary dump is chosen, the tool will produce an ASCII formatted dump such that each line of the tool's output contains all of the band file information from a single scan except for the scan data line (pixel data). The full dump option will follow each line of the summary dump with a hexadecimal dump of the image data.
Calibration file dump	The calibration file dump tool will allow the user to choose whether a summary dump or a full dump is desired for a range of scan lines. If a summary dump is chosen, the tool will produce an ASCII formatted dump such that each line of the tool's output contains all of the calibration file information from a single scan except for the calibration data line (pixel data). The full dump option will follow each line of the summary dump with a hexadecimal dump of the image data.
MSCD file dump	The MSCD file dump tool will produce an ASCII formatted dump for a user-specified range of scan lines such that each line of the tool's output contains all of the MSCD file information from a single scan.
PCD file dump	The PCD file dump tool will produce an ASCII formatted dump for a user-specified range of PCD major frames. The user will be able to specify whether or not the PCD major frame data is to be included in the output.
Browse file dump	The browse file dump tool will generate a formatted ASCII dump of the text information associated with the browse file and a hexadecimal dump of the image data associated with the file.
Database table dump	The database dump tool will present the user with a list of the LPGS database tables. The user will then be able to select which table to dump and whether all fields or a predetermined subset of the fields are desired. Alternatively, the user may execute a script that will dump the contents of each table into a file.

Metadata files will be in an ASCII PVL format that can be viewed by using the UNIX cat or more commands. No dump tool is needed.

The gtedit utility will be used to view hexadecimal dumps of trouble files. A comparator (e.g., UNIX diff program) will be used for regression tests to compare the output from the current build to that of previous builds.

7.2.3 Test Execution Scripts

UNIX shell scripts will be developed to: reinitialize the test environment (e.g., set database values back to a known starting point), combine frequently executed commands, and automate regression tests.

7.2.4 Test Tool Design and Reuse

To the greatest extent possible, attempts will be made to reuse tools and scripts that already exist. Other projects (e.g., LPS, IAS) will be investigated to determine if any tools or scripts exist that can be reused. Additionally, all LPGS tools and scripts that are either acquired or developed for use on the LPGS will be placed in a common area so that they may be shared among all of the development and the test groups.

7.2.5 Test Tool Development, Verification and Configuration

Test tools will be developed by:

GTSIM: GTSIM personnel
ECS simulator   LPGS development/LPGS system test
dump/analysis tools   LPGS development/LPGS system test

All test tools must be verified and placed under configuration control before testing begins for the build in which the tools will be used. This configuration control may be formal (i.e., the tools are placed into the project's configuration control system) or informal (i.e., changes to the tools are controlled by limiting write access to the executable files). Typically, tools that have been developed to dump data files or simulate external systems will be formally controlled, while test execution scripts will be informally controlled.

7.3 Test Data

The following subsections describe details of the data that are planned for testing the LPGS.

List of Landsat 4/5 scenes to be run through GTSIM and converted to Landsat 7 raw format:

The scenes of Colorado Springs and White Sands.

- Minnesota   Path 28   Row 29
- Georgia   Path 18   Rows 37 & 38
- White Sands (specific scene with markers for radiometry)
- Cloudy scene   Path 172   Row 32

7.3.1 Test Data Determination

Test data will be designed with several purposes in mind:
o   to verify that the LPGS correctly processes data containing the characteristics that are nominally received from the Landsat Ground Station (LGS)
o   to verify the functionality of the LPGS software
o   to stress the LPGS data processing algorithms
o   to verify that the LPGS correctly processes data containing the errors that are most likely to occur during the mission's lifetime

Some test data of the nominal size will be required. Most will be smaller in order to allow for quicker generation, evaluation, and ease of storage.

7.3.2 Test Data Generation and Verification

The Generic Telemetry Simulator (GTSIM) (and its associated utility programs) will be used to generate simulated data in the format that will be received from ECS. The current GTSIM hardware cannot support files larger than 2 GB. As test data files greater than 1.6 GB will be required for LPGS verification, GTSIM will be ported to one of the LPGS computers in order to perform generation of these large files. Before being used for LPGS verification, each test data file will be examined to verify that it contains the expected test data characteristics.

7.4 Personnel Resources

The following subsections describe details of the staff planned for testing the LPGS and otherwise supporting the test teams.

7.4.1 Test Personnel

At the end of each development phase, a team will be assembled to perform the subsystem integration and testing. This team will be formed from the development, system engineering, and system test organizations.

System tests will typically be conducted by a team of three people. These people will perform the build/release test planning, test data and tool preparation, and test execution. All test personnel will require skills in UNIX and Oracle. Training will be required for personnel who do not already have the necessary experience.

7.4.2 Support Personnel

In order to write effective test procedures, test personnel will have to work closely with development personnel during the test planning phase for each build. The developers will ensure that the testers fully understand how to operate the system and analyze test results before testing begins.

During each test execution phase, it is expected that a primary contact person will be designated from each of the following areas to support test problem resolution and facility scheduling:
- software development
- system engineering
- configuration management
- product assurance
- system administration
- IAS
- ECS

7.5 Schedule Requirements

For each build, as module testing is completed for each subsystem, the subsystems will be promoted to the integration test environment. As each subsystem is added, tests will be conducted to integrate the new subsystem with the rest of the system. After all subsystems have been promoted to this level, a nominal 2 week integration test period will begin.

The system test execution phase will be conducted over a 2 month period, following successful completion of integration testing. The first few days are typically used to perform and verify the installation of software in the system test environment. Confidence test are executed to verify that the build was successful, and that the integration test and system test environments are configured correctly. At least one week before each official software turnover to System Test, an "engineering" version of the software will be made available to the system test team so that dry runs of the test procedures can be performed.

Abbreviations and Acronyms

AAS	Anomaly Analysis Subsystem
API	applications programming interface
cNMOS	consolidated Network and Mission Operations Support
COTS	commercial off-the-shelf
CPU	central processing unit
DAAC	Distributed Active Archive Center
DBMS	Database Management System
DD	data dictionary
DDE	data dictionary entry
DFD	data flow diagram
DHF	Data Handling Facility
ECS	EOSDIS Core System
EDC	EROS Data Center
EGS	EOS Ground System
EOS	Earth Observing System
EOSAT	Earth Observation Satellite Company
EOSDIS	EOS Data and Information System
EROS	Earth Resources Observing System
ESDIS	Earth Science Data Information System
ETM+	Enhanced Thematic Mapper Plus
F&PRS	functional and performance requirements specification
FAST	an output format for L1G digital images
FDDI	fiber distributed data interface
FIFO	first in, first out
GB	gigabytes
GDS	ground data system
GeoTIFF	an output format for L1G digital images

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GPS	Geometry Process Subsystem
GSFC	Goddard Space Flight Center
GUI	graphical user interface
HDF	Hierarchical Data Format
HWC	hardware component
HWCI	hardware configuration item
I/O	input/output
IAS	Image Assessment System
IC	internal calibrator
ICD	interface control document
IDD	interface data descriptions
IDL	Interactive Development Language
IGS	international ground station
ISO	International Standards Organization
L0R	Level 0R
L1	Level 1
L1G	Level 1G
L1R	Level 1R
LGN	Landsat ground network
LGS	Landsat 7 ground station
LPGS	Level 1 Product Generation System
LPS	Landsat 7 Processing System
M	meter
MB	megabytes
Mbps	megabytes per second
MDS	Manage Data Subsystem
mm	millimeter
MMO	Mission Management Office
MO&DSD	Mission Operations and Data Systems Directorate
MOC	Mission Operations Center

MSCD	mirror scan correction data
MTF	modulation transfer function
MTTR	mean time to restore
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
NFS	Network File System
NOAA	National Oceanic and Atmospheric Administration
PC	personal computer
PCD	payload correction data
PCMB	Project Configuration Management Board
PCS	Process Control Subsystem
QA	quality assessment
QAS	Quality Assessment Subsystem
RAID	redundant array of inexpensive devices
RMA	reliability, maintainability, and availability
RPC	remote procedure call
RPS	Radiometry Process Subsystem
RSI	Research Systems, Inc.
RTM	Requirements and Traceability Management (tool)
SDR	system design review
SDS	system design specification
SGI	Silicon Graphics, Inc.
SNR	signal-to-noise ratio
SRR	system requirements review
SWCI	software configuration item
SQL	Structured Query Language
TBD	to be determined
TBR	to be resolved
TBS	to be supplied
TIFF	tagged image file format

URL   uniform resource locator

USGS   United States Geological Survey

WRS   Worldwide Reference System

WWW   world-wide web

Glossary

0R: The stage in the processing before radiometric or geometric correction of an image and after the pixels have been placed in detector spatial order.

L0R product: Products distributed by the ECS to include all bands, 0R image data, metadata, internal calibrator data, calibration parameter file, the browse image, the PCD, and the MSCD.

L1R: The stage in the processing after radiometric correction has been applied to an image and geometric coefficients are appended but not applied.

L1G: The final stage in the processing after radiometric and geometric corrections have been applied to the image data.

Ancillary data: Spacecraft attitude and ephemeris, radiometric correction coefficients, geometric processing parameters, and image quality statistics.

Archive: Off-line storage of data, software, and documentation.

Data storage: On-line storage of data accessible to the various functions within the LPGS

ETM+ equivalent scene:

L0R image data $(6320+225) \times 5984 \times 6 + ((12640 + 450) \times 11968) +$
     $((3160 + 113) \times 2992 \times 2) = 0.41$ GB

Level 1G, nonrotated, resampled to 25 meters (except Pan to 12.5 meters)
     220km x 170km/(.025km/pix)^2 x 2bytes/pix x 7 bands +
     220km x 170km/(.0125km/pix)^2 x 2bytes/pix = 1.3 GB

Geodetic accuracy: The accuracy relative to the geodetic reference surface, the earth ellipsoid.

Geometric accuracy: The measure of internal distortion of an image.

Geometric artifacts: Assessment of geometric artifacts (or assessment of geometric accuracy) includes visual assessment of discontinuities of linear features, scale distortion, panoramic distortion, and any other distortions.

Geometric processing parameters: Orbit parameters, instrument and alignment parameters, focal plane band locations, scan mirror profile coefficients (along scan and across scan), odd detector sample shifts, alignment matrices, Angular Displacement Sensor (ADS) calibration parameters, gyro calibration parameters, along scan focal plane detector offsets, temperature calibration coefficients, inoperable modes, resampling coefficients, MTF coefficients, and MTF compensation.

L0R scene product: See L0R product.

L1G digital image: Image data that have been both radiometrically and geometrically corrected .

L1R digital image: Image data that have been radiometrically corrected and to which geometric coefficients are appended but not applied.

REVIEW

<u>Payload correction data (PCD)</u>: The PCD contains all data required by ground stations to geometrically correct ETM+ sensor data, and it redundantly provides the ETM+ imaging configuration. The PCD is embedded in every wideband data virtual channel data unit (VCDU) at a rate of 4 bytes of PCD per VCDU. PCD data items are

ADS
ADS temperature
Gyro data
Gyro drift data
Attitude estimate
Time of last SV clock update
SV time drift characterization data
Ephemeris
ETM+ telemetry data
Spacecraft ID and time code
Multiplexer status
PDF A/D ground reference
Minor frame synchronization
Major frame identification
Spacecraft identifier
Attitude control system mode
ETM+ on/off times

<u>Radiometric image artifacts</u>: Striping, banding, scan-correlated shift, bright target recovery response (a.k.a. memory effect), coherent noise, impulse noise, detector saturation, and detector inoperability.

Appendix A. LPGS Requirements Allocation to Subsystem Matrix

Rqmt. No.	Requirement Summary	PCS	DMS	RPS	GPS	QAS	AAS
3.1	**System-Level Requirements**						
3.1.1	The LPGS shall nominally generate L1 data products on a FIFO basis.	X	X				
3.1.2	The LPGS shall provide the capability to move a Level 1 image processing work order within the FIFO queues according to operator direction.						
3.1.3	**Deleted**						
3.1.4	**Deleted**						
3.1.5	The LPGS shall provide the capability to generate and report LPGS error messages.	X	X	X	X	X	X
3.1.6	The LPGS shall provide an interactive capability to facilitate detection and correction of abnormal system conditions.	X	X	X	X	X	X
3.1.7	The LPGS shall provide the capability to isolate system faults.	X					X
3.1.8	The LPGS shall provide the capability to recover from system faults.	X					
3.1.9	The LPGS shall provide the capability to test LPGS functions and external interfaces.	X	X	X	X	X	X
3.1.10	The LPGS shall provide the capability to support attended operations 24 hours per day, 7 days per week, on a continuous basis.	X	X	X	X	X	X
3.1.11	The LPGS shall provide the capability to support unattended, automatic processing 16 hours per day, 7 days per week, on a continuous basis.	X	X	X	X	X	
3.1.12	The LPGS shall provide the capability to support Landsat 7 operations for a minimum mission life of 5 years.	X	X	X	X	X	X
3.1.13	The LPGS shall provide the capability to execute diagnostic tests for verifying proper operation of system capabilities and components.	X	X	X	X	X	X
3.1.14	The LPGS shall provide the capability to support end-to-end testing of Level 1 processing functions.	X	X	X	X	X	X
3.1.15	The LPGS shall provide the capability to control LPGS operations.		X				
3.1.16	The LPGS shall provide the capability to monitor LPGS operations.		X				X
3.1.17	The LPGS shall provide the capability to reconfigure LPGS system resources.						
3.1.18	The LPGS shall provide the capability to support software upgrades while supporting normal operations.	X	X	X	X	X	X

Rqmt. No.	Requirement Summary	PCS	DMS	RPS	GPS	QAS	AAS
3.1.19	The LPGS shall be capable of making all software and databases used in operations accessible to ECS for archiving.		X				
3.1.20	The LPGS design shall be scaleable to allow for future growth in processing capability.	X	X	X	X	X	X
3.1.21	The LPGS shall be able to generate level 1 digital images corresponding to either heritage world-wide reference system (WRS) scenes or to a partial ETM+ subinterval up to an area equivalent to three WRS scenes.			X	X		
3.1.22	The LPGS shall be capable of recovering from failures and aborts in a controlled manner.	X	X	X	X	X	X
3.2	**External Interface Requirements**						
3.2.1	The LPGS shall interface with ECS to receive the following:						
3.2.1.1	L0R files (includes associated PCD files, MSCD files, and CPFs)		X				
3.2.1.2	Level 1 image processing requests		X				
3.2.1.3	Data availability notification		X				
3.2.1.4	Production status requests **THIS REQ DELETED**						
3.2.1.5	Product cancellation requests **THIS REQ DELETED**						
3.2.1.6	Product problem report (trouble ticket)		X				X
3.2.2	The LPGS shall interface with ECS to coordinate transfer of the following:						
3.2.2.1	LPGS L1 digital images		X				
3.2.2.2	Processing status **THIS REQ DELETED**						
3.2.2.3	Production quality and accounting information **THIS REQ Modified to remove accounting info**						
3.2.2.4	L1 processing statistics **THIS REQ DELETED**						
3.2.2.5	L1 metadata		X				
3.2.2.6	PCD file (consensus)		X				
3.2.2.7	MSCD file (consensus)		X				
3.2.2.8	IC data file		X				
3.2.2.9	CPF		X				
3.2.2.10	Geolocation table		X				
3.2.3	The LPGS shall interface with the IAS to provide Level 1 radiometric characterization data.		X	X			
3.2.4	The LPGS shall interface with DHF to provide L1 processing anomaly reports. **THIS REQ DELETED**						
3.3	**Functional Requirements**						

Rqmt. No.	Requirement Summary	PCS	DMS	RPS	GPS	QAS	AAS
3.3.1	Retrieve L0R files.						
3.3.1.1	The LPGS shall provide the capability to receive L0R data inputs from ECS. This data shall include the following items:		X				
3.3.1.1.1	Level 1 image processing request that includes the following:						
3.3.1.1.1a	Selected coordinate reference system for map projection		X				
3.3.1.1.1b	Requested orientation (Nominal Path or North Up)		X				
3.3.1.1.1c	Variable grid cell size selection		X				
3.3.1.1.1d	Output format selection		X				
3.3.1.1.1e	Resampling filter		X				
3.3.1.1.1f	Selected bands		X				
3.3.1.1.1g	Selected scene or subinterval identification		X				
3.3.1.1.1h	L1R or L1G image processing selection		X				
3.3.1.1.1i	Geographic area		X				
3.3.1.1.1j	WRS (path/row) scene identifier		X				
3.3.1.1.1k	IC or CPF (default = CPF)		X				
3.3.1.1.2	Data availability notification specifying the location of associated L0R product files ready for retrieval		X				
3.3.1.1.3	L0R product files (includes L0R image data, PCD, MSCD, and associated calibration files), IC, and calibration parameter		X				
3.3.1.1.4	Production status request **THIS REQ DELETED**						
3.3.1.1.5	Product cancellation request **THIS REQ DELETED**						
3.3.1.1.6	Product problem report (trouble ticket)		X				X
3.3.1.2	The LPGS shall provide the capability to create and send L0R product requests to ECS.		X				
3.3.1.3	The LPGS shall coordinate resolution of data transfer problems with any L0R product file with ECS.						
3.3.1.3.1	The LPGS shall be able to detect data transfer problems.		X				
3.3.1.3.2	The LPGS shall be able to re-retrieve data.		X				
3.3.2	The LPGS shall be able to extract and process Landsat 7 ETM+ Earth image data from the L0R Earth image data file to produce radiometrically corrected L1R digital images.			X			
3.3.2.1	The LPGS shall be able to extract and process attitude, and ephemeris data from the L0R PCD files.		X	X			
3.3.2.2	The LPGS shall be able to extract parameters from the L0R IC or CPF for use in L1R and L1G processing.		X	X			
3.3.2.3	The LPGS shall be able to generate gains and biases from either IC data or from the CPF. The default shall be the CPF.			X			
3.3.2.4	The LPGS shall be able to extract and process mirror scan correction coefficients from the L0R MSCD file to determine scan line quality.		X	X			

Rqmt. No.	Requirement Summary	PCS	DMS	RPS	GPS	QAS	AAS
3.3.2.5	The LPGS shall be capable of detecting the following image artifacts:						
3.3.2.5.1	Striping		X	X			
3.3.2.5.2	Banding		X	X			
3.3.2.5.3	Coherent noise		X	X			
3.3.2.5.4	Deleted						
3.3.2.5.5	Scan-correlated shift		X	X			
3.3.2.5.6	Saturated detectors		X	X			
3.3.2.5.7	Dropped scan lines		X	X			
3.3.2.6	The LPGS shall be capable of characterizing the following image artifacts:						
3.3.2.6.1	Striping			X			
3.3.2.6.2	Banding			X			
3.3.2.6.3	Coherent noise			X			
3.3.2.6.4	**THIS REQ DELETED**						
3.3.2.6.5	**THIS REQ DELETED**						
3.3.2.6.6	Saturated detectors			X			
3.3.2.6.7	Dropped scan lines			X			
3.3.2.7	The LPGS shall be capable of applying compensation for the following image artifacts:						
3.3.2.7.1	Striping			X			
3.3.2.7.2	Banding			X			
3.3.2.7.3	Coherent noise			X			
3.3.2.7.4	Memory effect			X			
3.3.2.7.5	Scan correlated shift			X			
3.3.2.7.6	Inoperable detectors			X			
3.3.2.7.7	Saturated detectors			X			
3.3.2.7.8	Dropped scan lines			X			
3.3.2.8	The LPGS shall be capable of applying compensation for gain changes within a requested L1 scene or subinterval as identified in the L0R metadata.			X			
3.3.2.9	The LPGS shall be capable of producing L1R data from L0R data for both the ascending and descending portions of the Landsat 7 orbit.			X			
3.3.2.10	The LPGS shall be able to produce L1R digital images for any combination of the eight spectral channels.			X			
3.3.2.11	The LPGS shall assemble and append to the L1R digital images all of the applicable metadata and quality and accounting data gathered in the construction of the L1R digital image. The complete L1R digital image package contains the following data elements as a minimum:						
3.3.2.11.1	Level 1R digital image (all requested bands)		X				

Rqmt. No.	Requirement Summary	PCS	DMS	RPS	GPS	QAS	AAS
3.3.2.11.2	L1 metadata file		X				
3.3.2.11.3	**THIS REQ DELETED**						
3.3.3	The LPGS shall be able to extract and process Landsat 7 ETM+ Earth image data from the L1R Earth image data files to produce systematically corrected L1G digital images.				X		
3.3.3.1	The LPGS shall have the capability to resample L1R digital images and apply the following map projections:				X		
3.3.3.1.1	Space oblique Mercator				X		
3.3.3.1.2	Universal Transverse Mercator (UTM)				X		
3.3.3.1.3	Lambert conformal conic				X		
3.3.3.1.4	Transverse Mercator				X		
3.3.3.1.5	Oblique Mercator				X		
3.3.3.1.6	Polyconic				X		
3.3.3.1.7	Polar stereographic				X		
3.3.3.2	The LPGS shall support the following compensation resampling methods:						
3.3.3.2.1	Nearest neighbor				X		
3.3.3.2.2	Cubic convolution				X		
3.3.3.2.3	Modulation Transfer Function (MTF)				X		
3.3.3.3	The LPGS shall have the capability to produce L1G digital images with the following grid cell characteristics:						
3.3.3.3.1	Grid cell size is variable from 15M to 60M in 0.001M increments				X		
3.3.3.3.2	Grid cell size is independently variable between spectral bands				X		
3.3.3.4	The LPGS shall produce L1G digital images that are spatially continuous between contiguous partial subintervals or WRS scenes.				X		
3.3.3.5	The LPGS shall have the capability to generate L1G digital images oriented by the following:				X		
3.3.3.5.1	Oriented to Nominal Path				X		
3.3.3.5.2	Oriented to North Up				X		
3.3.3.6	The LPGS shall be capable of producing L1G data from L0R data for both the ascending and descending portions of the Landsat 7 orbit.				X		
3.3.3.7	The LPGS shall be able to produce L1G digital images for any combination of the eight spectral channels.				X		
3.3.3.8	The LPGS shall assemble and append to the L1G digital images all of the applicable metadata, quality and accounting data gathered in the construction of the L1G digital image. The complete L1G digital image package contains the following data elements as a minimum:		X				
3.3.3.8.1	Level 1G digital image (all requested bands)		X				
3.3.3.8.2	L1 metadata file		X				

Rqmt. No.	Requirement Summary	PCS	DMS	RPS	GPS	QAS	AAS
3.3.3.8.3	**THIS REQ DELETED**						
3.3.4	**Generate L1 metadata file.**						
3.3.4.1	The LPGS shall generate ancillary L1R digital image data that describes the contents, processing parameters, and quality indicators of the L1R digital image.		X	X			
3.3.4.2	The LPGS shall generate ancillary L1G digital image that describes the contents, processing parameters, and quality indicators of the L1G digital image.		X		X		
3.3.4.3	The LPGS shall generate and append processing summary indicators specifying the algorithms applied to the Level 1 digital images.		X				
3.3.5	**Assess L1 product quality**.						
3.3.5.1	The LPGS shall support automatic assessment of L1 digital image quality.					X	
3.3.5.2	The LPGS shall be able to optionally display any single band of the L1R digital image for visual quality assessment.					X	X
3.3.5.3	The LPGS shall be able to optionally display any single band of the L1G digital image for visual quality assessment					X	X
3.3.5.4	The LPGS shall be able to optionally print a color hardcopy of the display of any band(s) of the L1R digital image for visual quality assessment.					X	X
3.3.5.5	The LPGS shall be able to optionally print a color hardcopy of the display of any band(s) of the L1G digital image for visual quality assessment.					X	X
3.3.6	**Transfer L1 file(s).**						
3.3.6.1	The LPGS shall be able to output L1 digital images in the following formats:						
3.3.6.1.1	HDF-EOS (L1R and L1G)		X				
3.3.6.1.2	EOSAT FAST-Format (L1G only)		X				
3.3.6.1.3	GeoTIFF (L1G only)		X				
3.3.6.2	The LPGS shall transfer L1 files to ECS per the ECS to LPGS ICD.		X				
3.3.6.3	The LPGS shall provide the capability to display LPGS Level 1 file transfer summary upon operator request.		X				
3.3.6.4	The LPGS shall be able to detect files that have been successfully transferred.		X				
3.3.6.5	The LPGS shall be able to mark successfully transferred files as candidates for deletion from LPGS temporary storage.		X				
3.3.7	**Data storage**						
3.3.7.1	The LPGS shall be able to provide temporary online storage for the equivalent of 3 days of completed products. **NOTE: CCR SUBMITTED TO REWORD THIS REQUIREMENT**		X				

Rqmt. No.	Requirement Summary	PCS	DMS	RPS	GPS	QAS	AAS
3.3.7.2	The LPGS shall be able retransmit files located in temporary storage.		X				
3.3.7.3	The LPGS shall be able to store Level 1 processing information on line for 90 days.						
3.3.7.4	The LPGS shall be able to transfer Level 1 processing information to offline storage after 90 days.		X				
3.3.7.5	The LPGS shall be able to recover, display, and print Level 1 processing information located on offline storage for the life of the mission.		X				
3.3.8	**Control LPGS operations.**						
3.3.8.1	The LPGS shall allow the operator to select thresholds for statistics and errors reported by the LPGS.						
3.3.8.2	The LPGS shall automatically generate messages and alarms to alert the operator of LPGS results and errors exceeding operator selected thresholds.	X	X	X	X	X	
3.3.8.3	The LPGS shall generate intermediate processing summaries on a periodic basis according to operator specification.	X		X	X		
3.3.8.4	The LPGS shall provide an option to display L1 digital image quality status and statistics at operator request.	X				X	X
3.3.8.5	The LPGS shall provide an option to print L1 digital image quality status and statistics at operator request.	X				X	X
3.3.8.6	The LPGS shall provide the capability to manually override the LPGS automated processing functions.						
3.3.8.7	The LPGS shall provide the manual capability to cancel Level 1 processing prior to completion of digital image generation.	X					
3.3.8.8	The LPGS shall be able to display and print trouble tickets received from ECS.						X
4.1	**LPGS Performance Requirements**						
4.1.1	The LPGS shall be capable of processing a volume of data equivalent to 28 (accounts for 10 percent of LPGS internal reprocessing) standard L0R WRS scenes to Level 1 digital images each day.	X	X	X	X	X	
4.1.2	The LPGS shall contribute no greater than .7 percent uncertainty to absolute radiometric accuracy during the generation of L1R and 1G digital images.			X	X		
4.1.3	The LPGS shall contribute circular errors no greater than 1.8 m, 1 sigma, in the production of systematically corrected L1G digital images.				X		
4.1.4	The LPGS shall provide at least 110 percent of the processing throughput capability required to satisfy the worst case processor loading.						
4.1.5	The LPGS shall provide at least 125 percent of the random access memory capacity required to satisfy the worst case memory loading.						

Rqmt. No.	Requirement Summary	PCS	DMS	RPS	GPS	QAS	AAS
4.1.6	The LPGS shall provide at least 125 percent of the peripheral storage capacity required to satisfy the worst case peripheral storage loading.						
4.1.7	**THIS REQ DELETED**						
4.1.8	The LPGS shall produce Level 1G products that are accurate to within 250 meters cross track and 250 meters along track using geometric calibration information generated by IAS and contained in the associated calibration parameter file.				X		
4.1.9	LPGS shall provide the capability to register pixels from a band to the corresponding pixels of the other bands in a common scene to an accuracy of 0.28 sensor GSD, 0.9p, in along-track and cross-track directions, providing all inputs are within specification. The accuracy is relative to the largest sensor GSD of the registered bands. **THIS REQ ADDED**				X		
4.2	**External Interface Performance Requirements**						
4.2.1	The LPGS shall be able to ingest from ECS a data volume equivalent to 3 WRS scenes' worth of standard L0R data for each Level 1 digital image request.		X				
4.2.2	The LPGS shall have the capability to support the transfer to ECS of the equivalent of a minimum of 25 WRS sized Level 1 digital images per day.		X				
4.2.3	The LPGS-ECS interface shall provide the capability to transfer to the ECS at least 33 GB of Level 1 output files per day.		X				
4.3	Reliability, maintainability, and availability.						
4.3.1	The LPGS shall provide an operational availability of 0.96 (TBR).	X	X	X	X	X	X
4.3.2	The LPGS shall support a mean time to restore (MTTR) capability of 4 hours (TBR).	X	X	X	X	X	X
4.4	**Security.**						
4.4.1	The LPGS shall provide system, network, and operations security according to the ESDIS security policy (Applicable Document 8) and the NASA AIS Handbook (Applicable Document 9).	X	X	X	X	X	X

Appendix B. LPGS Requirements & Verification Matrix

I=Inspection   A=Analysis   D=Demonstration   T=Test

REQ #	Requirement Summary	I	A	D	T
3.1	**SYSTEM-LEVEL REQUIREMENTS**				
3.1.1	The LPGS shall nominally generate Level 1 digital images on a first ordered, first processed (FIFO) basis.				x
3.1.2	The LPGS shall provide the capability to move a Level 1 image processing work order within the FIFO queues according to operator direction.			x	x
3.1.3	Deleted				
3.1.4	Deleted				
3.1.5	The LPGS shall provide the capability to generate and report LPGS error messages.				x
3.1.6	The LPGS shall provide an interactive capability to facilitate detection and correction of abnormal system conditions				x
3.1.7	The LPGS shall provide the capability to isolate system faults.			x	
3.1.8	The LPGS shall provide the capability to recover from system faults.			x	
3.1.9	The LPGS shall provide the capability to test LPGS functions and external interfaces.			x	x
3.1.10	The LPGS shall provide the capability to support attended operations 24 hours per day, 7 days per week, on a continuous basis.	N	A		
3.1.11	The LPGS shall provide the capability to support unattended, automatic processing 16 hours per day, 7 days per week, on a continuous basis.			x	
3.1.12	The LPGS shall provide the capability to support Landsat 7 operations for a minimum mission life of 5 years.	N	A		
3.1.13	The LPGS shall provide the capability to execute diagnostic tests for verifying proper operation of system capabilities and components.				x
3.1.14	The LPGS shall provide the capability to support end-to-end testing of Level 1 processing functions.				x
3.1.15	The LPGS shall provide the capability to control LPGS operations.				x
3.1.16	The LPGS shall provide the capability to monitor LPGS operations.				x

REQ #	Requirement Summary	I	A	D	T
3.1.17	The LPGS shall provide the capability to reconfigure LPGS system resources.				x
3.1.18	The LPGS shall provide the capability to support software upgrades while supporting normal operations.			x	x
3.1.19	The LPGS shall be capable of making all software and databases used in operations accessible to ECS for archiving.			x	x
3.1.20	The LPGS design shall be scaleable to allow for future growth in processing capability.		x		
3.1.21	The LPGS shall be able to generate Level 1 digital images corresponding to either heritage Worldwide Reference System (WRS) scenes or to a partial ETM+ subinterval up to an area equivalent to three WRS scenes.				x
3.1.22	The LPGS shall be capable of recovering from failures and aborts in a controlled manner.			x	x
3.2	**EXTERNAL INTERFACE REQUIREMENTS**				
3.2.1	The LPGS shall interface with the ECS to receive:				x
3.2.1.1	L0R files (includes associated PCD, MSCD, and CPF)				x
3.2.1.2	Level 1 image processing requests				x
3.2.1.3	Data availability notification				x
3.2.1.4	Production status requests				x
3.2.1.5	Product cancellation requests				x
3.2.1.6	Product problem report (Trouble Ticket)				x
3.2.2	The LPGS shall interface with the ECS to coordinate the transfer of the following:				
3.2.2.1	LPGS L1 digital images				x
3.2.2.2	Processing status				x
3.2.2.3	Production quality and accounting information				x
3.2.2.4	L1 processing statistics				x
3.2.2.5	L1 metadata				x
3.2.2.6	PCD file (consensus)				x
3.2.2.7	MSCD file (consensus)				x
3.2.2.8	IC data file				x
3.2.2.9	CPF				x
3.2.2.10	Geolocation table				x
3.2.3	The LPGS shall interface with the Image Assessment System (IAS) to provide Level 1 radiometric characterization data.				x
3.2.4	The LPGS shall interface with the Data Handling Facility (DHF) to provide Level 1 processing anomaly reports.				x
3.3	**FUNCTIONAL REQUIREMENTS**				
3.3.1	Retrieve L0R files.				x

REQ #	Requirement Summary	I	A	D	T
3.3.1.1	The LPGS shall provide the capability to receive L0R data inputs from the ECS. This data shall include the following items:				x
3.3.1.1.1	Level 1 image processing request that includes the following:				x
3.3.1.1.1a	Selected coordinate reference system for map projection				x
3.3.1.1.1b	Requested orientation (nominal path or north up)				x
3.3.1.1.1c	Variable grid cell size selection				x
3.3.1.1.1d	Output format selection				x
3.3.1.1.1e	Resampling filter				x
3.3.1.1.1f	Selected band(s)				x
3.3.1.1.1g	Selected scene or subinterval identification				x
3.3.1.1.1h	L1R or L1G image processing selection				x
3.3.1.1.1i	Geographic area				x
3.3.1.1.1j	WRS (path/row) scene identifier				x
3.3.1.1.1k	Internal calibrator (IC) or Calibration Parameter File (CPF) (default = CPF)				x
3.3.1.1.2	Data availability notification specifying the location of associated L0R product files ready for transfer				x
3.3.1.1.3	L0R product files (includes L0R image data, PCD, MSCD and associated Calibration files [internal calibrator and calibration parameter files])				x
3.3.1.1.4	Production status request				x
3.3.1.1.5	Product cancellation request				x
3.3.1.1.6	Product problem report (Trouble Ticket)				x
3.3.1.2	The LPGS shall provide the capability to create and send L0R product requests to the ECS				x
3.3.1.3	The LPGS shall coordinate resolution of data transfer problems with any L0R product file with ECS			x	
3.3.1.3.1	The LPGS shall be able to detect data transfer problems.			x	x
3.3.1.3.2	The LPGS shall be able to reorder data.				x
	Generate L1R Digital Images				
3.3.2	The LPGS shall be able to extract and process Landsat 7 ETM+ Earth image data from the L0R Earth image data file to produce radiometrically corrected L1R digital images.				x
3.3.2.1	The LPGS shall be able to extract and process attitude and ephemeris data from the L0R Payload Correction Data (PCD) files.				x
3.3.2.2	The LPGS shall be able to extract parameters from the L0R internal calibrator or calibration parameter file for use in L1R and L1G processing.				x

REQ #	Requirement Summary	I	A	D	T
3.3.2.3	The LPGS shall be able to generate gains and biases from either the internal calibrator data or from the calibration parameter file. The default shall be the calibration parameter file				x
3.3.2.4	The LPGS shall be able to extract and process mirror scan correction coefficients from the L0R MSCD file to determine scan line quality.				x
3.3.2.5	The LPGS shall be capable of detecting the following image artifacts:				x
3.3.2.5.1	Striping				x
3.3.2.5.2	Banding				x
3.3.2.5.3	Coherent noise				x
3.3.2.5.4	Deleted				
3.3.2.5.5	Scan-correlated shift				x
3.3.2.5.6	Saturated detectors				x
3.3.2.5.7	Dropped scan lines				x
3.3.2.6	The LPGS shall be capable of characterizing the following image artifacts:				x
3.3.2.6.1	Striping				x
3.3.2.6.2	Banding				x
3.3.2.6.3	Coherent noise				x
3.3.2.6.4	Deleted				
3.3.2.6.5	Deleted				
3.3.2.6.6	Saturated detectors				x
3.3.2.6.7	Dropped scan lines				x
3.3.2.7	The LPGS shall be capable of applying compensation for the following image artifacts:				x
3.3.2.7.1	Striping				x
3.3.2.7.2	Banding				x
3.3.2.7.3	Coherent noise				x
3.3.2.7.4	Memory effect				x
3.3.2.7.5	Scan-correlated shift				x
3.3.2.7.6	Inoperable detectors				x
3.3.2.7.7	Saturated detectors				x
3.3.2.7.8	Dropped scan lines				x
3.3.2.8	The LPGS shall be capable of applying compensation for gain changes within a requested L1 scene or subinterval as identified in the Level 0 metadata.				x
3.3.2.9	The LPGS shall be capable of producing L1R data from L0R data for both the ascending and descending portions of the Landsat 7 orbit				x

REQ #	Requirement Summary	I	A	D	T
3.3.2.10	The LPGS shall be able to produce L1R digital images for any combination of the eight spectral channels.				x
3.3.2.11	The LPGS shall assemble and append to the L1R digital images all of the applicable metadata, quality and accounting data gathered in the construction of the L1R digital image. The complete L1R digital image package contains the following data elements as a minimum:				x
3.3.2.11.1	Level 1R digital image (all requested bands)				x
3.3.2.11.2	Level 1 metadata file				x
3.3.2.11.3	Deleted				
	Generate L1G Digital Images				
3.3.3	The LPGS shall be able to extract and process Landsat 7 ETM+ Earth image data from the L1R Earth image data files to produce systematically corrected L1G digital images.				x
3.3.3.1	The LPGS shall have the capability to resample L1R digital images and apply the following map projections:				x
3.3.3.1.1	Space Oblique Mercator				x
3.3.3.1.2	Universal Transverse Mercator (UTM)				x
3.3.3.1.3	Lambert Conformal Conic				x
3.3.3.1.4	Transverse Mercator				x
3.3.3.1.5	Oblique Mercator				x
3.3.3.1.6	Polyconic				x
3.3.3.1.7	Polar Stereographic				x
3.3.3.2	The LPGS shall support the following compensation resampling methods:				x
3.3.3.2.1	Nearest neighbor				x
3.3.3.2.2	Cubic convolution				x
3.3.3.2.3	Modulation Transfer Function (MTF)				x
3.3.3.3	The LPGS shall have the capability to produce L1G digital images with the following grid cell characteristics:				x
3.3.3.3.1	Grid cell size is variable from 15M to 60M in 0.001M increments			x	x
3.3.3.3.2	Grid cell size is independently variable between spectral bands				x
3.3.3.4	The LPGS shall produce L1G digital images that are spatially continuous between contiguous partial subintervals or WRS scenes.				x
3.3.3.5	The LPGS shall have the capability to generate L1G digital images oriented by the following:				x
3.3.3.5.1	Nominal Path				x

REQ #	Requirement Summary	I	A	D	T
3.3.3.5.2	North Up				x
3.3.3.6	The LPGS shall be capable of producing L1G data from L0R data for both the ascending and descending portions of the Landsat 7 orbit.				x
3.3.3.7	The LPGS shall be able to produce L1G digital images for any combination of the eight spectral channels.				x
3.3.3.8	The LPGS shall assemble and append to the L1G digital images all applicable metadata, quality and accounting data gathered in the construction of the L1G digital image. The complete L1G digital image package contains the following data elements as a minimum:				x
3.3.3.8.1	Level 1G digital image (all requested bands)				x
3.3.3.8.2	L1 Metadata files				x
3.3.3.8.3	Deleted				
3.3.4	**Generate L1 Metadata File.**				
3.3.4.1	The LPGS shall generate ancillary L1R digital image data that describes the contents, processing parameters, and quality indicators of the L1R digital image.				x
3.3.4.2	The LPGS shall generate ancillary L1G digital image data that describes the contents, processing parameters, and quality indicators of the L1G digital image.				x
3.3.4.3	The LPGS shall generate and append processing summary indicators specifying the algorithms applied to the Level 1 digital images.			x	x
3.3.5	**Assess Level 1 Digital Image Quality.**				
3.3.5.1	The LPGS shall support automatic assessment of L1 digital image quality.				x
3.3.5.2	The LPGS shall be able to optionally display any single band of the L1R digital image for visual quality assessment				x
3.3.5.3	The LPGS shall be able to optionally display any single band of the L1G digital image for visual quality assessment.				x
3.3.5.4	The LPGS shall be able to optionally print a color hard copy of the display of any band(s) of the L1R digital image for visual quality assessment				x
3.3.5.5	The LPGS shall be able to optionally print a color hard copy of the display of any band(s) of the L1G digital image for visual quality assessment.				x
3.3.6	**Transfer Level 1 File(s).**				
3.3.6.1	The LPGS shall be able to output Level 1 digital images in the following formats:				x

REQ #	Requirement Summary	I	A	D	T
3.3.6.1.1	HDF-EOS (*L1R and L1G*)				x
3.3.6.1.2	EOSAT FAST (*L1G Only*)				x
3.3.6.1.3	GeoTIFF (*L1G Only*)				x
3.3.6.2	The LPGS shall transfer L1 files to ECS per the ECS to LPGS ICD.			x	
3.3.6.3	The LPGS shall provide the capability to display LPGS Level 1 file transfer summary upon operator request.				x
3.3.6.4	The LPGS shall be able to detect files which have been successfully transferred.			x	x
3.3.6.5	The LPGS shall be able to mark successfully transferred files as candidates for deletion from LPGS temporary storage.			x	x
3.3.7	**Data Storage**				
3.3.7.1	The LPGS shall be able to provide temporary online storage for the equivalent of 3 days of completed products			x	
3.3.7.2	The LPGS shall be able retransmit files located in temporary storage.				x
3.3.7.3	The LPGS shall be able to store Level 1 processing information online for 90 days.			x	
3.3.7.4	The LPGS shall be able to transfer Level 1 processing information to offline storage after 90 days			x	
3.3.7.5	The LPGS shall be able to recover, display, and print Level 1 processing information located on offline storage for the life of the mission			x	x
3.3.8	**Control LPGS Operations.**				
3.3.8.1	LPGS shall allow the operator to select thresholds for statistics and errors reported by the LPGS.				x
3.3.8.2	LPGS shall automatically generate messages and alarms to alert the operator of LPGS results and errors exceeding operator-selected thresholds.				x
3.3.8.3	The LPGS shall generate intermediate processing summaries on a periodic basis according to operator specification.				x
3.3.8.4	The LPGS shall provide an option to display Level 1 digital image quality status and statistics at operator request.				x
3.3.8.5	The LPGS shall provide an option to print Level 1 digital image quality status and statistics at operator request.				x
3.3.8.6	The LPGS shall provide the capability to manually override the LPGS automated processing functions.				x
3.3.8.7	The LPGS shall provide the manual capability to cancel Level 1 processing prior to completion of digial image generation.				x

REQ #	Requirement Summary	I	A	D	T
3.3.8.8	The LPGS shall be able to display and print trouble tickets received from ECS				x
4.1	**PERFORMANCE REQUIREMENTS**				
4.1.1	The LPGS shall be capable of processing a volume of data equivalent to 28 (accounts for 10 percent LPGS internal reprocessing) standard L0R WRS scenes to Level 1 digital images each day				x
4.1.2	The LPGS shall contribute no greater than .7 percent uncertainty to absolute radiometric accuracy during the generation of L1R and L1G digital images.		x		x
4.1.3	The LPGS shall contribute circular errors no greater than 1.8 m, 1 sigma, in the production of systematically corrected L1G digital images		x		x
4.1.4	The LPGS shall provide at least 110 percent of the processing throughput capability required to satisfy the worst case processor loading.		x		
4.1.5	The LPGS shall provide at least 125 percent of the random access memory capacity required to satisfy the worst case memory loading.		x		
4.1.6	The LPGS shall provide at least 125 percent of the peripheral storage capacity required to satisfy the worst case peripheral storage loading.		x		
4.1.7	Deleted				
4.1.8	The LPGS shall produce Level 1G products that are accurate to within 250 meters cross track and 250 meters along track using geometric calibration information generated by IAS and contained in the associated calibration parameter file		x		x
4.1.9	LPGS shall provide the capability to register pixels from a band to the corresponding pixels of the other bands in a common scene to an accuracy of 0.28 sensor GSD, 0.9p, in along-track and cross-track directions, providing all inputs are within specification. The accuracy is relative to the largest sensor GSD of the registered bands.		x		x
4.2	**External Interface Performance Requirements.**				
4.2.1	The LPGS shall be able to ingest from ECS a data volume equivalent to three WRS scenes worth of standard L0R data for each Level 1 digital image request.				x
4.2.2	The LPGS shall have the capability to support the transfer to ECS of the equivalent of a minimum of 25 WRS sized Level 1 digital images per day.			x	x
4.2.3	The LPGS-ECS interface shall provide the capability to transfer to the ECS at least 33 Gbytes of Level 1 output files per day.			x	

REVIEW

REQ #	Requirement Summary	I	A	D	T
4.3	**Reliability, maintainability, and availability.**				
4.3.1	The LPGS shall provide an operational availability of 0.96 (TBR).			x	
4.3.2	The LPGS shall support a mean time to restore (MTTR) capability of 4 hours (TBR).			x	
4.4	**Security**				
4.4.1	The LPGS shall provide system, network, and operations security according to the ESDIS security policy (Applicable Document 10) and the NASA AIS Handbook (Applicable Document 9)	N	A		

Appendix C. LPGS Requirements Traceability Matrix

REQ #	Test Case	Requirement Summary
3.1		**SYSTEM-LEVEL REQUIREMENTS**
3.1.1	1.01,1.02,1.03, 1.04, 1.05, 1.07,4.11	The LPGS shall nominally generate Level 1 digital images on a first ordered, first processed (FIFO) basis.
3.1.2	2.00, 3.07, 3.21	The LPGS shall provide the capability to move a Level 1 image processing work order within the FIFO queues according to operator direction.
3.1.3	Deleted	
3.1.4	Deleted	
3.1.5	1.10, 2.03, 3.05,3.06, 8.03, S1.15	The LPGS shall provide the capability to generate and report LPGS error messages.
3.1.6	8.03, S1.15	The LPGS shall provide an interactive capability to facilitate detection and correction of abnormal system conditions
3.1.7	Demo	The LPGS shall provide the capability to isolate system faults.
3.1.8	Demo	The LPGS shall provide the capability to recover from system faults.
3.1.9	1.00, 1.01, 1.02, 1.03, 1.06	The LPGS shall provide the capability to test LPGS functions and external interfaces.
3.1.10	N/A	The LPGS shall provide the capability to support attended operations 24 hours per day, 7 days per week, on a continuous basis.
3.1.11	Demo	The LPGS shall provide the capability to support unattended, automatic processing 16 hours per day, 7 days per week, on a continuous basis.
3.1.12	N/A	The LPGS shall provide the capability to support Landsat 7 operations for a minimum mission life of 5 years.
3.1.13	7.00, S1.00, S1.01, S1.02	The LPGS shall provide the capability to execute diagnostic tests for verifying proper operation of system capabilities and components.
3.1.14	7.01, S1.07	The LPGS shall provide the capability to support end-to-end testing of Level 1 processing functions.
3.1.15	S1.05. S1.06	The LPGS shall provide the capability to control LPGS operations.

REQ #	Test Case	Requirement Summary
3.1.16	2.01, 2.04, 3.02, 3.03, 3.07, 3.08 - 3.11, 3.19, 7.02, S1.05, S1.06	The LPGS shall provide the capability to monitor LPGS operations.
3.1.17	12.05, S1.15	The LPGS shall provide the capability to reconfigure LPGS system resources.
3.1.18	S1.00,S1.08	The LPGS shall provide the capability to support software upgrades while supporting normal operations.
3.1.19	S1.03,S1.04	The LPGS shall be capable of making all software and databases used in operations accessible to ECS for archiving.
3.1.20	S1.07	The LPGS design shall be scaleable to allow for future growth in processing capability.
3.1.21	2.16, 12.00	The LPGS shall be able to generate Level 1 digital images corresponding to either heritage Worldwide Reference System (WRS) scenes or to a partial ETM+ subinterval up to an area equivalent to three WRS scenes.
3.1.22	8.06	The LPGS shall be capable of recovering from failures and aborts in a controlled manner.
3.2		**EXTERNAL INTERFACE REQUIREMENTS**
3.2.1	3.00, 3.01, 9.00 - 9.06, 9.16, 9.17, 9.19, 9.20, 9.21, 10.00	The LPGS shall interface with the ECS to receive:
3.2.1.1	2.05 - 2.15, 3.22, 3.23, 3.24, 9.01, 9.19	L0R files (includes associated PCD, MSCD, and CPF)
3.2.1.2	9.02	Level 1 image processing requests
3.2.1.3	9.03	Data availability notification
3.2.1.4	Deleted	Production status requests
3.2.1.5	Dereted	Product cancellation requests
3.2.1.6	9.04	Product problem report (Trouble Ticket)
3.2.2	3.00, 3.01	The LPGS shall interface with the ECS to coordinate the transfer of the following:
3.2.2.1	1.00,1.01,1.02, 1.03,1.04,1.06, 1.08, 10.00	LPGS L1 digital images
3.2.2.2	Deleted	Processing status
3.2.2.3	10.01	Production quality and accounting information
3.2.2.4	Deleted	L1 processing statistics

REQ #	Test Case	Requirement Summary
3.2.2.5	10.02	L1 metadata
3.2.2.6	10.02	PCD file (consensus)
3.2.2.7	10.02	MSCD file (consensus)
3.2.2.8	10.03	IC data file
3.2.2.9	10.04	CPF
3.2.2.10	10.05	Geolocation table
3.2.3	4.00, 10.06	The LPGS shall interface with the Image Assessment System (IAS) to provide Level 1 radiometric characterization data.
3.2.4	Deleted	The LPGS shall interface with the Data Handling Facility (DHF) to provide Level 1 processing anomaly reports.
3.3		**FUNCTIONAL REQUIREMENTS**
3.3.1	2.16, 9.01, 9.05 - 9.22	Retrieve L0R files.
3.3.1.1	2.05 - 2.15, 3.00, 3.01, 3.22, 3.23, 3.24, 9.00, 9.05	The LPGS shall provide the capability to receive L0R data inputs from the ECS. This data shall include the following items:
3.3.1.1.1	9.06	Level 1 image processing request that includes the following:
3.3.1.1.1a	9.07	Selected coordinate reference system for map projection
3.3.1.1.1b	9.08	Requested orientation (nominal path or north up)
3.3.1.1.1c	9.09	Variable grid cell size selection
3.3.1.1.1d	9.10	Output format selection
3.3.1.1.1e	9.11	Resampling filter
3.3.1.1.1f	9.12	Selected band(s)
3.3.1.1.1g	9.13	Selected scene or subinterval identification
3.3.1.1.1h	9.14	L1R or L1G image processing selection
3.3.1.1.1i	9.15	Geographic area
3.3.1.1.1j	9.16	WRS (path/row) scene identifier
3.3.1.1.1k	9.17	Internal calibrator (IC) or Calibration Parameter File (CPF) (default = CPF)
3.3.1.1.2	9.18	Data availability notification specifying the location of associated L0R product files ready for transfer
3.3.1.1.3	9.19	L0R product files (includes L0R image data, PCD, MSCD and associated Calibration files [internal calibrator and calibration parameter files])
3.3.1.1.4	Deleted	Production status request
3.3.1.1.5	Deleted	Product cancellation request
3.3.1.1.6	9.04	Product problem report (Trouble Ticket)

REQ #	Test Case	Requirement Summary
3.3.1.2	10.07	The LPGS shall provide the capability to create and send L0R product requests to the ECS
3.3.1.3	Demo	The LPGS shall coordinate resolution of data transfer problems with any L0R product file with ECS
3.3.1.3.1	9.20	The LPGS shall be able to detect data transfer problems.
3.3.1.3.2	9.21	The LPGS shall be able to reorder data.
		Generate L1R Digital Images
3.3.2	4.02	The LPGS shall be able to extract and process Landsat 7 ETM+ Earth image data from the L0R Earth image data file to produce radiometrically corrected L1R digital images.
3.3.2.1	4.03	The LPGS shall be able to extract and process attitude and ephemeris data from the L0R Payload Correction Data (PCD) files.
3.3.2.2	4.04	The LPGS shall be able to extract parameters from the L0R internal calibrator or calibration parameter file for use in L1R and L1G processing.
3.3.2.3	4.05	The LPGS shall be able to generate gains and biases from either the internal calibrator data or from the calibration parameter file. The default shall be the calibration parameter file
3.3.2.4	4.06	The LPGS shall be able to extract and process mirror scan correction coefficients from the L0R MSCD file to determine scan line quality.
3.3.2.5	4.07	The LPGS shall be capable of detecting the following image artifacts:
3.3.2.5.1	4.07, 11.06	Striping
3.3.2.5.2	4.07, 11.06	Banding
3.3.2.5.3	4.07, 11.03	Coherent noise
3.3.2.5.4	Deleted	Deleted
3.3.2.5.5	4.07, 11.02	Scan-correlated shift
3.3.2.5.6	4.07, 11.04	Saturated detectors
3.3.2.5.7	4.07, 11.00	Dropped scan lines
3.3.2.6	4.08	The LPGS shall be capable of characterizing the following image artifacts:
3.3.2.6.1	4.08, 11.06	Striping
3.3.2.6.2	4.08, 11.06	Banding
3.3.2.6.3	4.08, 11.03	Coherent noise
3.3.2.6.4	Deleted	Deleted
3.3.2.6.5	Deleted	Deleted
3.3.2.6.6	4.08, 11.04	Saturated detectors
3.3.2.6.7	4.08, 11.00	Dropped scan lines
3.3.2.7	4.09, 11.06	The LPGS shall be capable of applying compensation for the following image artifacts:

REQ #	Test Case	Requirement Summary
3.3.2.7.1	4.09, 11.06	Striping
3.3.2.7.2	4.09, 11.06	Banding
3.3.2.7.3	4.09, 11.03	Coherent noise
3.3.2.7.4	4.09, 11.01	Memory effect
3.3.2.7.5	4.09, 11.02	Scan-correlated shift
3.3.2.7.6	4.09	Inoperable detectors
3.3.2.7.7	4.09, 11.04	Saturated detectors
3.3.2.7.8	4.09, 11.00	Dropped scan lines
3.3.2.8	4.10	The LPGS shall be capable of applying compensation for gain changes within a requested L1 scene or subinterval as identified in the Level 0 metadata.
3.3.2.9	4.11	The LPGS shall be capable of producing L1R data from L0R data for both the ascending and descending portions of the Landsat 7 orbit
3.3.2.10	4.12	The LPGS shall be able to produce L1R digital images for any combination of the eight spectral channels.
3.3.2.11	4.13	The LPGS shall assemble and append to the L1R digital images all of the applicable metadata, quality and accounting data gathered in the construction of the L1R digital image. The complete L1R digital image package contains the following data elements as a minimum:
3.3.2.11.1	4.14	Level 1R digital image (all requested bands)
3.3.2.11.2	4.14	Level 1 metadata file
3.3.2.11.3	Deleted	Deleted
		Generate L1G Digital Images
3.3.3	6.01	The LPGS shall be able to extract and process Landsat 7 ETM+ Earth image data from the L1R Earth image data files to produce systematically corrected L1G digital images.
3.3.3.1	6.02	The LPGS shall have the capability to resample L1R digital images and apply the following map projections:
3.3.3.1.1	6.02	Space Oblique Mercator
3.3.3.1.2	6.02	Universal Transverse Mercator (UTM)
3.3.3.1.3	6.02	Lambert Conformal Conic
3.3.3.1.4	6.02	Transverse Mercator
3.3.3.1.5	6.02	Oblique Mercator
3.3.3.1.6	6.02	Polyconic
3.3.3.1.7	6.02	Polar Stereographic
3.3.3.2	6.03	The LPGS shall support the following compensation resampling methods:

REQ #	Test Case	Requirement Summary
3.3.3.2.1	6.03	Nearest neighbor
3.3.3.2.2	6.03	Cubic convolution
3.3.3.2.3	6.03, 11.05	Modulation Transfer Function (MTF)
3.3.3.3	6.04	The LPGS shall have the capability to produce L1G digital images with the following grid cell characteristics:
3.3.3.3.1	6.04	Grid cell size is variable from 15M to 60M in 0.001M increments
3.3.3.3.2	6.04	Grid cell size is independently variable between spectral bands
3.3.3.4	6.05	The LPGS shall produce L1G digital images that are spatially continuous between contiguous partial subintervals or WRS scenes.
3.3.3.5	6.06	The LPGS shall have the capability to generate L1G digital images oriented by the following:
3.3.3.5.1	6.06	Nominal Path
3.3.3.5.2	6.06	North Up
3.3.3.6	6.07	The LPGS shall be capable of producing L1G data from L0R data for both the ascending and descending portions of the Landsat 7 orbit.
3.3.3.7	6.08	The LPGS shall be able to produce L1G digital images for any combination of the eight spectral channels.
3.3.3.8	6.09	The LPGS shall assemble and append to the L1G digital images all applicable metadata, quality and accounting data gathered in the construction of the L1G digital image. The complete L1G digital image package contains the following data elements as a minimum:
3.3.3.8.1	6.09	Level 1G digital image (all requested bands)
3.3.3.8.2	6.09	L1 Metadata files
3.3.3.8.3	Deleted	Deleted
3.3.4		**Generate L1 Metadata File.**
3.3.4.1	3.01	The LPGS shall generate ancillary L1R digital image data that describes the contents, processing parameters, and quality indicators of the L1R digital image.
3.3.4.2	6.00	The LPGS shall generate ancillary L1G digital image data that describes the contents, processing parameters, and quality indicators of the L1G digital image.
3.3.4.3	4.15, 6.10,S1.09, S1.10	The LPGS shall generate and append processing summary indicators specifying the algorithms applied to the Level 1 digital images.
3.3.5		**Assess Level 1 Digital Image Quality.**
3.3.5.1	5.00, 5.06, S1.12	The LPGS shall support automatic assessment of L1 digital image quality.

REQ #	Test Case	Requirement Summary
3.3.5.2	5.01, 7.03	The LPGS shall be able to optionally display any single band of the L1R digital image for visual quality assessment
3.3.5.3	5.02, 7.04	The LPGS shall be able to optionally display any single band of the L1G digital image for visual quality assessment.
3.3.5.4	5.03, 7.05, S1.14	The LPGS shall be able to optionally print a color hard copy of the display of any band(s) of the L1R digital image for visual quality assessment
3.3.5.5	5.04, 7.06	The LPGS shall be able to optionally print a color hard copy of the display of any band(s) of the L1G digital image for visual quality assessment.
3.3.6		**Transfer Level 1 File(s).**
3.3.6.1	1.00, 1.01, 1.02, 1.03	The LPGS shall be able to output Level 1 digital images in the following formats:
3.3.6.1.1	1.01	HDF-EOS (*L1R and L1G*)
3.3.6.1.2	1.02	EOSAT FAST (*L1G Only*)
3.3.6.1.3	1.03	GeoTIFF (*L1G Only*)
3.3.6.2	1.04	The LPGS shall transfer L1 files to ECS per the ECS to LPGS ICD.
3.3.6.3	1.05, 7.07	The LPGS shall provide the capability to display LPGS Level 1 file transfer summary upon operator request.
3.3.6.4	1.06	The LPGS shall be able to detect files which have been successfully transferred.
3.3.6.5	1.07	The LPGS shall be able to mark successfully transferred files as candidates for deletion from LPGS temporary storage.
3.3.7		**Data Storage**
3.3.7.1	Demo	The LPGS shall be able to provide temporary online storage for the equivalent of 3 days of completed products
3.3.7.2	1.08	The LPGS shall be able retransmit files located in temporary storage.
3.3.7.3	Demo	The LPGS shall be able to store Level 1 processing information online for 90 days.
3.3.7.4	Demo	The LPGS shall be able to transfer Level 1 processing information to offline storage after 90 days
3.3.7.5	2.02, S1.13, S1.14	The LPGS shall be able to recover, display, and print Level 1 processing information located on offline storage for the life of the mission
3.3.8		**Control LPGS Operations.**
3.3.8.1	1.09	LPGS shall allow the operator to select thresholds for statistics and errors reported by the LPGS.
3.3.8.2	1.10, 2.03, 3.05, 3.06, S1.15	LPGS shall automatically generate messages and alarms to alert the operator of LPGS results and errors exceeding operator-selected thresholds.

REQ #	Test Case	Requirement Summary
3.3.8.3	1.11,1.17 - 1.21, 2.02, 2.04, 3.02, 3.03, 3.04, 3.12 - 3.20, 7.08 - 7.11, 11.07 - 11.10, S1.11	The LPGS shall generate intermediate processing summaries on a periodic basis according to operator specification.
3.3.8.4	1.12, 1.17 - 1.21, 7.07, 11.08, 11.09, 11.10, S1.11	The LPGS shall provide an option to display Level 1 digital image quality status and statistics at operator request.
3.3.8.5	1.13, 1.17 - 1.21, 3.04, 11.07 - 11.10	The LPGS shall provide an option to print Level 1 digital image quality status and statistics at operator request.
3.3.8.6	1.14, 8.04	The LPGS shall provide the capability to manually override the LPGS automated processing functions.
3.3.8.7	1.15, 8.00, 8.01, 8.02,8.05	The LPGS shall provide the manual capability to cancel Level 1 processing prior to completion of digial image generation.
3.3.8.8	1.16, 9.06	The LPGS shall be able to display and print trouble tickets received from ECS
4.1		**PERFORMANCE REQUIREMENTS**
4.1.1	11.00	The LPGS shall be capable of processing a volume of data equivalent to 28 (accounts for 10 percent LPGS internal reprocessing) standard L0R WRS scenes to Level 1 digital images each day
4.1.2	4.16, 6.11, 12.01	The LPGS shall contribute no greater than .7 percent uncertainty to absolute radiometric accuracy during the generation of L1R and L1G digital images.
4.1.3	5.05, 6.12, 12.02	The LPGS shall contribute circular errors no greater than 1.8 m, 1 sigma, in the production of systematically corrected L1G digital images
4.1.4	Analysis	The LPGS shall provide at least 110 percent of the processing throughput capability required to satisfy the worst case processor loading.
4.1.5	Analysis	The LPGS shall provide at least 125 percent of the random access memory capacity required to satisfy the worst case memory loading.
4.1.6	Analysis	The LPGS shall provide at least 125 percent of the peripheral storage capacity required to satisfy the worst case peripheral storage loading.
4.17	Deleted	Deleted

REQ #	Test Case	Requirement Summary
4.1.8	12.03	The LPGS shall produce Level 1G products that are accurate to within 250 meters cross track and 250 meters along track using geometric calibration information generated by IAS and contained in the associated calibration parameter file
4.1.9	12.04	LPGS shall provide the capability to register pixels from a band to the corresponding pixels of the other bands in a common scene to an accuracy of 0.28 sensor GSD, 0.9p, in along-track and cross-track directions, providing all inputs are within specification. The accuracy is relative to the largest sensor GSD of the registered bands.
4.2		**External Interface Performance Requirements.**
4.2.1	2.16, 3.22, 9.14	The LPGS shall be able to ingest from ECS a data volume equivalent to three WRS scenes worth of standard L0R data for each Level 1 digital image request.
4.2.2	3.23, 10.08	The LPGS shall have the capability to support the transfer to ECS of the equivalent of a minimum of 25 WRS sized Level 1 digital images per day.
4.2.3	2.01, 10.09	The LPGS-ECS interface shall provide the capability to transfer to the ECS at least 33 Gbytes of Level 1 output files per day.
4.3		**Reliability, maintainability, and availability.**
4.3.1	Demo	The LPGS shall provide an operational availability of 0.96 (TBR).
4.3.2	Demo	The LPGS shall support a mean time to restore (MTTR) capability of 4 hours (TBR).
4.4		**Security**
4.4.1	N/A	The LPGS shall provide system, network, and operations security according to the ESDIS security policy (Applicable Document 10) and the NASA AIS Handbook (Applicable Document 9)